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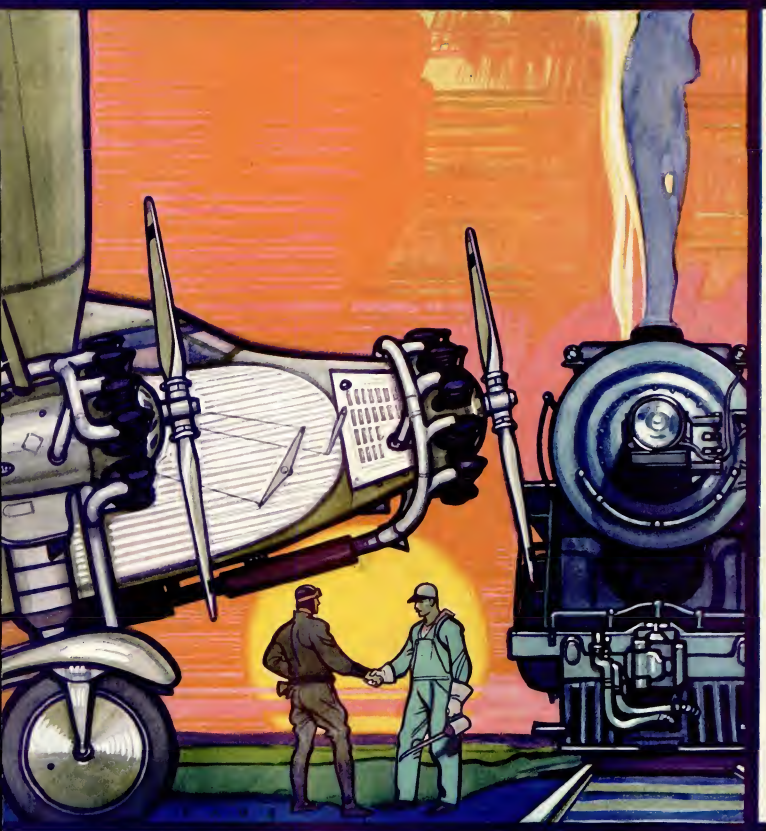

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The Western Electric System has many advantages which appeal to progressive hospital managements. Architects and engineers value it because it is electrically reliable, made by the makers of your telephone.

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WHAT IS NEW THIS MONTH

Table of Contents for November

LEADING ARTICLES

SPECIAL FEATURES

Astronomy

Automobiles

Aviation

November, 1929, Vol. 115, No. 5. **Popular Science Monthly** is published monthly at 381 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry at second-class matter at Chicago, Illinois. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Copyright, 1929, by the Popular Science Publishing Co., Inc. Single copy, 25 cents. Yearly subscriptions to United States, its possessions, and Canada, $2.50; foreign countries, $3.

Engineering

Exceptional People

Health and Hygiene

Nature

New Devices for the Home

New Processes and Inventions

Radio

Ships

Unusual Facts and Ideas

For the Home Owner

Hints for the Mechanic

Ideas for the Handy Man

12 MILLION INVESTORS Who *Don't Watch* the Ticker

By WALLACE AMES, *Financial Editor*

"THE whole world is pop-eyed . . . crazy over speculation . . . hypnotized by the stock ticker." Thus burst forth Louis Danby as he threw down his New York paper one morning a few weeks ago.

"How come?" inquired his partner.

"According to today's paper they have begun to put stock tickers on ocean liners," exclaimed the disgusted Danby. Matters have reached a pretty pass when people can't even leave the stock market long enough to take an ocean voyage. Has every one been bitten by the speculative bug?"

"Good morning, folks," greeted Tom Wooster, who had entered the store while Louis Danby was delivering his tirade. "I happened to overhear your remarks about everyone being stock market crazy. It may seem that way to you, but from where I sit the first Monday night of each month I get an entirely different picture."

"What do you see from where you sit?" inquired Danby.

"I see a long line of good, substantial people of this town, investing their savings in our building and loan association. The other day I received a report which shows that at the close of 1928 there were 12,666 of these associations all over the country, with assets of $8,016,034,327, belonging to 11,995,905 investors. Almost twelve million people —nearly one to every other family in the United States—with over eight billion dollars laid away for the future in building and loan shares! What do you think of that?"

"It sounds like a lot of money and a lot of people," agreed Louis Danby, "but just the same this stock ticker mania has got on my nerves."

"Undoubtedly many people have been caught in the web of speculation who neither know how nor can afford to dabble in stocks," agreed Tom Wooster. "Enough of them are making money to encourage the rest to try their luck. But on the whole there may be more good than harm in it all. People are getting investment-conscious. . . they are all striving for financial independence. And millions are gaining independence through their building and loan accounts. I see nothing to worry about."

* * *

In two or three characteristics building and loan associations differ from most other saving and investment mediums. Being mutual in form there are no "insiders" participating in the profits of a building and loan association. All profits go to the shareholders, or members as they are usually called, each one participating to the extent of his shareholdings. Instead of paying a regular rate of interest quarterly or semi-annually, all profits from building and loan operations are re-invested, to make more profits, and the accumulated profits paid to the member when his shares mature. This plan produces the practical effect of compound interest. A third unique characteristic of building and loan associations is the requirement of regular savings. Members determine in advance how much they will save each month. Then they must deposit that amount on or before the same day each month. Members who are late in their payments are liable to small fines. These fines go to swell the profits of all members. Those who, because of unforseen circumstances, are unable to continue saving until their shares mature may withdraw entirely, receiving the current withdrawal value of the amount they have deposited.

The requirement of regularity proves to be more of a blessing than a curse. It makes saving a habit. Everyone knows from his own experience that compulsory or semi-compulsory saving means many an extra dollar in the nest-egg.

Building and loan shares mature when the amount paid in, plus profits, equals $200. To illustrate: Suppose you pay in $1 a month on one share. In 138 months, or 11½ years you will have paid in $138. Further assume that during that interval profits amount to $62. Your share would then mature and you would be paid $200. If profits are greater your shares mature in a shorter time; if profits are smaller it takes correspondingly longer to mature the shares. Maturities usually range between 11 and 13 years. Any established building and loan association can inform you of their approximate maturity term.

Through one building and loan plan you save $1 each month for each share that you take out. This may be designated as the Single Share Plan. This is the plan that matures in about 11 years or longer. Then there is a plan whereby you may deposit a lump sum, usually in multiples of $100, on which you receive a fixed rate of interest at regular intervals. Some associations call these Full Paid Shares.

By combinations of these plans quite a number of different systems for getting ahead may be developed. You can choose whatever plan best fits your circumstances. Following is a brief description of a few combinations.

COMBINATION No. 1

There are three steps to this plan, as follows:

First: Invest in Single Shares, paying for them at the rate of $1 a month per share. (*Continued on page 5*)

12 Million Investors Who Don't Watch the Ticker

(Continued from page 4)

Second: When your Single Shares mature invest the money you receive in Full Paid Shares.

Third: Use your income from Full Paid Shares to pay for a second series of Single Shares.

For the sake of this example we will assume your Full Paid Shares pay 6%, which would be sufficient to carry your second series without any additional saving on your part. You may even continue this plan into a third or a fourth series, without saving any part of your earned income after the first series of Single Shares is paid for.

To illustrate how rapidly money grows by this plan, let us assume that you subscribe for 25 Single Shares and that they mature in 11½ years or 138 months.

You deposit monthly	$ 25
In 138 months you deposit	3,450
Your profit in this period is	1,550
The matured value of your shares is	5,000

Your $5,000 invested in Full Paid Shares at 6% returns $300 a year or $25 a month.

This pays for your second series of 25 Single Shares which mature in a second period of 138 months at $5,000
You now have 10,000

This sum, invested in Full Paid Shares at 6% returns $600 a year or $50 a month.

With this money you may take out a third series of 50 Single Shares which, in another 138 months mature at $10,000.

Your total worth is now $20,000, of which amount you saved $3,450. The balance, $16,550, is interest or profit on the $3,450 saved. In 34½ years your money has multiplied itself nearly five times.

COMBINATION No. 2

This plan is for those who do not wish to invest on the monthly installment plan, but who desire to invest a lump sum outright and allow interest to accumulate until their principal is doubled.

First: Invest $100, $500, $1,000 or any sum in even hundreds in Full Paid Shares at 6%.

Second: Use the income from your Full Paid Shares to take out a series of Single Shares.

By this plan, whatever amount you invest outright in the beginning will be doubled when your Single Shares mature, since the Single Shares will mature for the same amount as your original investment.

COMBINATION No. 3

According to Combination No. 1 you discontinue your monthly savings after the first 138 months. Thereafter you depend on the income from your accumulations to increase your financial worth. Let us suppose that you decide *not* to discontinue your monthly deposits after the first series matures. Instead, you carry out Combination No. 1 and in addition take out an additional series of 25 Single Shares which you pay for out of earned income. Here is how your money grows on this basis:

During the first 138 months your $25 a month grows to $5,000

This sum, invested in 6% Full paid Shares, gives you a monthly income of $25.

12 Million Investors Who Don't Watch the Ticker

(*Continued from page 5*)

Add $25 monthly saved out of your earned income and you have $50 a month to invest in your second series of Single Shares.

During the second 138 months your $50 a month grows to.....$10,000
Your total worth is now.....15,000
This sum, invested in 6% Full Paid Shares, gives you $75 a month. Add $25 from your earned income, invest in a third series of 100 Single Shares which mature at.....$20,000
Now, at the end of 34½ years you are worth.....$35,000
To obtain this amount you have invested only.....$10,350

In order to simplify the examples we have used 138 months in all cases. If your shares mature in a shorter or longer period the actual result will be altered just that much. If your Full Paid Shares pay a rate of interest other than 6%, the final result will differ from our examples. It is not necessary to start with exactly $25 a month. Most building and loan associations accept monthly deposits as low as $5 a month and allow you to start with any amount in multiples of $5.

The three combination plans outlined here are not the only ones which you can work through the building and loan method. There are many others which you can devise yourself by using the two basic plans explained earlier in this article.

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"How to Build an Independent Income" is the title of a new booklet by the F. H. Smith Company which explains conclusively how people of moderate means may obtain financial prosperity. May be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

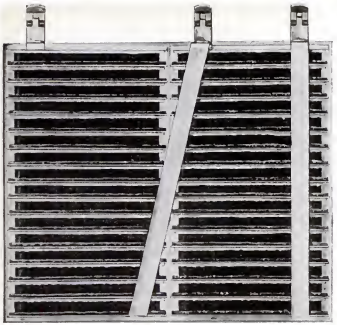
The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Edwin K. McCluer Company, 46 North Dearborn St., Chicago, Ill.

How to Get the Things You Want tells how you can *use* insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 328 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

"Money Doubling." This newly published pamphlet describes a feasible plan whereby the investor may double his money in less than six years by accumulating the stock of Financial Investing Co. of New York, Ltd., which he receives as quarterly dividends. It will be sent free on request addressed to The Fiscal Securities Corp., Room 2508, 48 Wall Street, New York City.



EVEREADY LAYERBILT CONSTRUCTION—*Here is the inside story of the Eveready Layerbilt—flat, space-saving cells making connections automatically. Only five solderings, only two broad connecting bands. Maximum reliability, maximum active materials, greatest life. Layerbilt construction is an exclusive Eveready feature. Only Eveready makes Layerbilt Batteries.*

CYLINDRICAL CELL CONSTRUCTION—*Here is the inside story about every "B" battery assembled of separate, individually sealed cells—29 fine connecting wires, 60 solderings, and lots of waste space between cells.*

» HERE'S THE INSIDE TRACK TO "B" BATTERY SERVICE «

IT'S as easy as ABC to choose the inside track to better "B" battery service. Simply buy Eveready Layerbilts. They are so built as to give you more economy, reliability and satisfaction. The diagrams tell you all there is to know about "B" batteries.

These diagrams show the two types of battery. One is the cylindrical cell kind. Such cylindrical cell batteries contain 29 fine wires, and 60 delicate solderings are needed to connect the individual cells together. These 89 places where trouble can come are found in every such battery, whether the cells are cylindrical, as is usual, or square or hexagonal or any other shape. There wasn't anything better until we invented the Eveready Layerbilt.

Now see the Eveready Layerbilt diagram. Note the flat *inter*dependent (not independent) cells, making connection with each other automatically. Only two broad connecting bands are required, each 3/8 inch wide. There are but five big husky solderings. This means super-reliability. The flat cells also pack more materials within the battery box, and so you get longer life—added convenience, economy and satisfaction.

You can get these advantages of Eveready Layerbilt construction only in an Eveready Layerbilt. This is a fully patented battery, and none other is like it. An Eveready Layerbilt is unique. Be sure the name is on the "B" batteries you buy.

This is the **LARGE SIZE** *Eveready Layerbilt "B" Battery for heavy duty, No.* **486,** *the longest lasting, most economical of all Eveready s. Price* **$4.25.** *There is also another Eveready Layerbilt, Medium Size, No.* **485,** *at* **$2.95.**

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Eveready Batteries are being used in automatic train control; aircraft beacon receivers; talking motion pictures; short wave transmission; picture transmission; television; for the protection of life and property, and to secure instant, unfailing, noiseless, perfect electrical power.

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NEW EVEREADY RADIO RECEIVERS, A. C. AND BATTERY OPERATED, NOW ON SALE

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

INDEX
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Popular Science GUARANTEE

POPULAR SCIENCE MONTHLY guarantees every article of merchandise advertised in its columns. Readers who buy products advertised in POPULAR SCIENCE MONTHLY may expect them to give absolute satisfaction under normal and proper use.

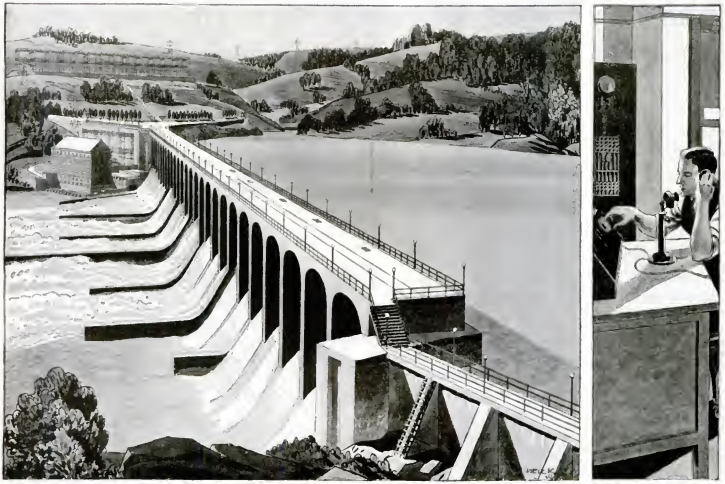
Tools, Radio Apparatus, Oil Burners and Refrigerators advertised in POPULAR SCIENCE MONTHLY have been tested or investigated by the Popular Science Institute of Standards and each advertisement carries the insignia indicating approval.

However, other products advertised in the magazine not subject to test carry the same guarantee to readers as products tested.

THE PUBLISHERS

WHAT WESTINGHOUSE IS DOING IN RESEARCH

DRAWN FOR WESTINGHOUSE BY C. PETER HELCK



WESTINGHOUSE CONTROL DEVICES MAKE TELEPHONED SIGNALS START AND STOP DISTANT UNATTENDED HYDRO-ELECTRIC STATIONS.

Thousands of horsepower controlled by a breath

A worker in a busy power plant notes the approaching hour when street cars will gather throngs of home-bound passengers and thousands of dwellings will ask for light. He picks up a telephone, dials a number—and listens. Miles away a water-driven generator, without a human hand to touch it, signals "O.K." and then, at an audible command, goes into action. Thousands of horsepower, stored up in the water above the dam, are set to work by a mere breath of energy—the faint vibrations of sound that operate sensitive electrical devices.

Automatic control and magnetic control are taking important places in today's industrial drama. They operate mechanisms that maintain the correct level in tanks or reservoirs or the desired temperature in furnaces. Uncanny devices guard the performance of huge paper machines or electric generators. Vigilant "eyes" inspect, count and sort merchandise. Alert "ears" listen over electric light wires and turn on street light switches at a signal from a supervisor's station.

Years of untiring research have been invested by Westinghouse engineers to give electricity these talents. Yet the opportunities have been barely touched. Westinghouse research is continually uncovering new industrial possibilities in the fields of automatic and magnetic control.

Westinghouse Electrification Appliances Apparatus Wiring

The Sign of a Westinghouse Dealer

Westinghouse

Distinguished by NATURAL TONE *and* *delightfully* RESPONSIVE *performance*

SENSITIVE? Yes. Easily tuned? Yes. Capable of great volume? By all means.

But more than these—*listeners marvel at the glorious tone of the new Day-Fan Radio.*

For Day-Fan has solved the problem of bringing in sweetly and clearly the silvery high notes—the elusive overtones—and the booming bass without sacrificing one iota of distance and power and selectivity.

Naturalness in Day-Fan Radio is achieved by detecting all the frequencies and correctly amplifying them — without over-emphasis — in an improved audio system.

Day-Fan Radio is modestly priced. In a beautiful walnut console shown above, the 9-tube set (two 245's in push-pull) with matched electro-dynamic speaker is $175 without tubes. (Priced slightly higher in Far West.)

DAY-FAN ELECTRIC COMPANY

1711 Wisconsin Boulevard
DAYTON, OHIO

Day-Fan Screen Grid Models

The new Screen Grid models employ three screen-grid tubes, correctly engineered to achieve the utmost in responsiveness from this new radio development. They are priced: Model 93, $189.50. Model 94, $240.

Day-Fan RADIO

Product of General Motors

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Oil Heat Scraps the Coal Shovel

Back-Breaking Toil of Ash Removal and Stoking Unknown with New Furnace Equipment

By COLLINS P. BLISS
Director, Popular Science Institute

The attention needed by a coal fire and the arduous and dirty task of removing and sifting ashes are eliminated by an oil burner installation.

RECENTLY I asked a man who had just installed an oil burner in his furnace why he had switched from coal to oil. "Been carrying ashes for thirty years," was his terse reply. That, I gathered, was all the reason he needed, but many home owners are attracted by other advantages of oil heat.

In the first place, when an oil burner is installed it does away forever with the unpleasant task of waiting on the furnace. There are no more fires to be built only to be extinguished in a day or two during uncertain fall and spring weather; no more starting up the furnace in the morning and banking it at night; no more trips to the cellar during the day in an attempt to cope with sudden changes in outdoor temperature. A good oil burner gives an automatic, clean, even heat—with no souvenirs in the form of ashes. These advantages are enough for the 500,000 Americans who have equipped their homes with oil heating devices.

Few people buy an oil burner for economy, though heating with oil quite often proves cheaper than burning coal. As a rule, oil at eight cents a gallon is the equivalent in cost of coal at $11.45 a ton. When this price ratio between the two fuels prevails, the factor that determines whether it will be cheaper to heat with oil is the efficiency and suitability of the heating system in which the oil burner is installed.

IT MUST be remembered that the oil burner is merely the heat-producing part of the heating system, and if the heating system is inefficient, old-fashioned, and unsuited to oil, the burner will have to work under a handicap and burn more oil than would be necessary under more favorable conditions. Investigations carried on by the Popular Science Institute show that when the quantity of oil consumed is greater than it should be, usually the boiler is at fault. For this reason, The Institute always advises the prospective user of oil heating equipment to find out if his heating system is of correct design and in good condition, and to make any necessary changes or improvements before he goes ahead with the installation. Adding an extra section or two to a boiler with inadequate heating surface may cut quite a slice off the annual oil bill.

Asking oil burner owners how much more they would be willing to pay for oil before they would go back to coal gives a pretty good slant on how satisfactory they have found oil heat. The majority of persons, when asked this question, say from twenty to thirty percent, and quite a number say that they would pay a hundred times as much for oil before they would give up using it. One man who has had his oil burner only one season said that he would pay $5,000 before he could be persuaded to return to his former method of heating.

OF COURSE, these people who are so satisfied with oil heat are using reliable oil heating devices, of which there are plenty now on the market. The mechanical development of oil burners has been carried to such a high point that today there is no question as to the efficiency and safety of the better makes. Some years have elapsed since oil heating devices outgrew the experimental stage, and there is no reason why the home owner should delay in installing oil heat. The last few seasons have not witnessed any pronounced changes in oil heating equipment; the general trend in the design of new models has been toward the simplification of mechanical details.

Speaking of the mechanism of an oil burner, there is a misunderstanding that should be dispelled. Some persons have the idea that oil burners are very complicated devices that get out of order very easily and require frequent professional attention. This is not true. Most owners of good burners find that it is necessary to call the service man only a few times in a season, and such calls that are made are usually for general inspection and adjustment, rather than for any particular breakdown or repair. A heating system that requires only rare visits from the service representative and none from the owner from one year to the next is certainly a rather close approach to the ideal; particularly so when it is remembered that house temperatures stay within two degrees of the point set by the owner during the whole heating season.

ALL the modern comforts of automatic oil heat may be had in any home that is equipped with a central heating system and wired for electricity. Financially, it is within the reach of every home owner who can afford an automobile or similar luxury-necessities.

* * *

Readers of POPULAR SCIENCE MONTHLY who are considering oil heat for their homes can secure advice on the subject and specific recommendation of reliable burners by writing to the Popular Science Institute, 381 Fourth Ave., New York, N.Y.

INSTITUTE BULLETINS

List of Approved Oil Heating Devices

Advice on Installing Oil Heat

Insulation in Building Construction*

List of Approved Radio Products

List of Approved Tools

List of Approved Refrigerators

Refrigeration for the Home*

*Price 25 cents each

For trucks in the city, for tractors in the country ..this *grainless* wood board

This grainless wood board, Masonite Presdwood, has hundreds of uses in industry and building. It does not crack, split or splinter, is almost impervious to moisture and highly resistant to warping and buckling. Is naturally beautiful; takes any finish. Production costs often drop off sharply when Presdwood is used. Samples to try out will be gladly sent on request.

FOR MOTOR TRUCK PANELING

Seen by thousands every day, a modern motor truck in city service portrays on its paneled sides of Masonite Presdwood an attractive sign which advertises the truck owner's business. Out on some windswept farm the operator of a toiling tractor is perfectly protected from flying sand and driving rain by a cab which is made of this same grainless wood.

In one case Presdwood is used for its strength, smooth surface and ability to take any paint finish. In the other it is employed for its resistance to moisture and the sturdiness which enables it to withstand the hardest kind of usage.

Has Hundreds of Uses

These qualities of strength and beauty, as well as the workability of a grainless board that does not crack or split, have made Masonite Presdwood the chosen material for hundreds of manufactured articles. It is used for bedroom screens and radio cabinets, clothes hampers and bread boxes, breakfast nooks and kitchen cabinets.

Because of Presdwood's smoothness and strength it is ideal for work-bench tops, ice box paneling, cupboards and shelving. It makes core trays in foundries, starch trays in candy factories; is employed for its moisture resisting ability in the construction of campers' tables, speed boat hulls, highway markers and outdoor signs of all kinds. In fact there seems to be no limit to the many uses for this grainless wood.

In the building industry, Presdwood is being used in ever increasing quantities. It panels fine homes and the more modern buildings, takes any commercial finish. In concrete construction, Presdwood is often used to line the forms, for it produces such a perfect smooth surface that the need of hand smoothing is practically eliminated.

FOR STURDY TRACTOR CABS

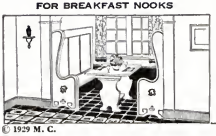
Liked by Mechanics Everywhere

Presdwood has made friends in factories because of its workability, for skilled artisans, familiar with every type of material, have been won over by the ease with which Presdwood can be punched, sawed, milled, or sanded. This grainless wood cuts production costs by eliminating the waste and costly rejections which result from defective material. Where handy men make things around the home, Presdwood is equally in demand, for anyone who uses tools instantly recognizes the possibilities of a grainless wood board that neither cracks, splits nor splinters.

Factory executives, builders and home owners should read the Presdwood booklet which tells how Presdwood is made, lists eighty of its many uses and gives instructions for applying many types of finishes. A copy of the booklet will be sent promptly on request.

MASONITE CORPORATION
Dept. 731, 111 West Washington Street
Chicago, Illinois

FOR BREAKFAST NOOKS



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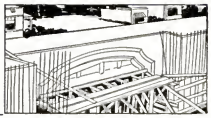
MASONITE STRUCTURAL INSULATION

FOR LINING CONCRETE FORMS



Our Readers Say

Where Did the Hours Go?

"CAN any of your readers answer this one? "A northbound plane is speeding from Los Angeles to San Francisco, aided by a favoring fifty-mile wind. Southward bound, another plane is bucking the same breeze, now a fifty-mile head wind. Does the first plane gain as much time as the second loses?

"It sounds reasonable —but it isn't so. Assume the air line distance between the two cities (in round numbers) as 300 miles; the speed of the planes in still air as 100 miles an hour. Now the northbound plane, with its extra speed from the favoring wind, travels at 150 miles an hour and consequently gets to its destination in two hours.

But the southbound machine, its speec reduced to only fifty miles an hour, requires six hours for the trip. The total is eight hours for what is normally a six-hour round trip. Somewhere the air transport line has lost two flying hours.

"The specific distance and the plane and wind speeds don't matter—the principle is the same for any. Where did the lost flying hours go?"—S. K., Portland, Ore.

Sniping at the Zeps

"IT SEEMS to me that POPULAR SCIENCE MONTHLY, in the article, 'The Zeppelin Grows Up,' is making too much fuss over airships.

"Perhaps I am a bit old-fashioned, but I can't see that the Zeppelins and their like are an achievement to excite any great enthusiasm, even though one does manage to travel around the world. What advantages have they over the good old ocean liners? Only the saving of less than twenty-four hours in the crossing of the Atlantic.

"On the other hand, think of the disadvantages. Airships are not so safe as liners—all but the *Los Angeles* and the *Graf Zeppelin* have met an untimely end. Then, they're not so commodious and they do not give a traveler the free deck space and the opportunity for leisurely enjoyment which a sea voyage does.

"Can't we have a little less space devoted to glorifying things that really aren't of such tremendous importance after all?"—H. J. S., Buffalo, N. Y.

When the Left Is Right

"YOUR editorial on 'Keep to the Right' is all right for the pedestrian on the sidewalk, and at the street intersections, but all wrong for him in the traffic on the highway.

"On the highway the pedestrian keeping to the right is traveling in the same direction as the speeding autos on his side of the road, and even if he obeys the rule of the road that slow-moving vehicles shall keep to the extreme right, he is in great danger because all the vehicles passing him are coming from behind, where he cannot see them. The drivers are all seated on the left side, and watching the traffic to their left, instead of to their right.

"The State of California has recognized the danger of this condition and has legalized the right of way of the pedestrian on the left side of the road, facing the traffic. This enables him to note the position and speed of the approaching vehicles and to step off the paved track at the left, if necessary, for safety."—H. R., Ocean Park, Calif.

Diamonds Bad Luck?

"I READ the other day a report by a member of the French Academy of Science that precious stones have a direct effect upon the health of the wearer. He stated that emeralds increase energy while diamonds reduce vitality, though apparently he offered no evidence to substantiate his theory.

"The belief that some precious stones have an influence upon the health and fortune of those who wear them has persisted from primitive times. The Greeks named the wine-colored amethyst 'not drunken.' It was supposed that the wearer of one of these stones would remain sober no matter how much wine he consumed. Another stone carefully preserved by early Mediterranean peoples was believed to have the power to cure snake bites. This 'snake - stone' was powdered and applied to the wound. Many people still think that wearing diamonds brings bad luck.

"The color of the blood-red jasper suggested that it might be connected with the human life stream. For a long time the belief was held that this stone by its magical powers could prevent hemorrhages. Another curious custom of primitive people was to present magnetic stones to brothers. So long as they preserved these stones, it was thought, the brothers would not fall out or quarrel.

"Is there really anything in all this superstition?"—J. T. M., Fort Worth, Tex.

No Rest for the Wicked

"I WANT to take issue with Dr. Bernard Hollander, 'British alienist and criminologist,' who says on your Editorial Page: 'Women are being troubled by disturbing dreams than men, probably because they have less work and worry.' May it be, Dr. Hollander, because they have fewer sins on their conscience?"—Mrs. D. B. J., Orange, N. J.

It Made a Hit

"I MADE our boy the large dump truck from plans in your Home Workshop. He likes the truck better than the electric train he received last Christmas."—F. J. K., Iowa Falls, Ia.

Or Why Not a Padlock?

"I NOTICE in your 'Back of the Month's News,' the following statement: 'Experts are not certain whether it (the rattlesnake) must vibrate the tip of its tail before it can strike, but agree that it never strikes without warning.'

"I am not setting myself up as an expert, but I do know something about rattlers. I was treated for a rattlesnake bite on May 18th of this year and the bite was delivered by a rattler that did not vibrate its tail or give any other warning.

"If it were true that a rattler could not strike until it vibrated its tail it would be comparatively simple to render the snake harmless. This would greatly simplify some folks' jobs. Casting the snakes' tails in plaster of Paris blocks would prevent the supposed very necessary vibrations. It would also silence the rattle, and surely no really honorable rattlesnake would strike if unable to give due and proper warning.

"I have had considerable experience with poisonous snakes and have no reason to believe that the tail exerts the slightest influence on the head or governs the striking in the slightest degree. I most certainly would have taken advantage of it if I were aware of it."—D. D. H. M., Haddon Heights, N. J.

A Handy File

"READERS of POPULAR SCIENCE MONTHLY who make a practice of keeping back copies of the magazine may be interested in indexing the articles which interest them. I got hold of a small index box measuring about four by four inches, and a set of index cards. And I hunted up my oldest issue of the magazine. When I saw an article that interested me I made out a card for it. At the top of the card I wrote a classification, such as 'Ship Models,' under which the subject of the article belonged. Then I put down the title of the article, the author's name, the month and year of the magazine, and the page on which the article could be found. Then I took the next issue and went through it the same way. This index is very handy, especially if one has a good many magazines to look through."—R. W. M., Melrose, Mass.

And Going Higher

"PLEASE do not alter a page or a line or even an advertisement. POPULAR SCIENCE is at its peak. I have tried nearly every magazine in print. POPULAR SCIENCE is the book that gives you a bit of everything and just enough of it. In its class it is the best that money can buy."—E. B., London, England.

Every Saturday... in every stadium... SORE THROAT!

Gargle with Listerine when you get home . . .

HERE, as any doctor will tell you, is a bit of sound wisdom for those who attend late season football games.

Before going, and after returning from them gargle with full strength Listerine. This pleasant little precaution may spare you a nasty siege with a cold or sore throat or their more dangerous complications.

Medical records show that after football games, there is marked increase in the number of cases of colds . . . sore throat . . . influenza and bronchitis.

They are caused by germs in the mouth which get the upper hand when body resistance is lowered by over exposure, change of temperature, and emotional disturbances, all of which are coincidental with seeing a football game.

Listerine checks them effectively because, used full strength, it is powerful against germs—kills them by the million.

Even such stubborn organisms as the Staphylococcus Aureus (pus) and Bacillus Typhosus (typhoid) in counts ranging to 200,000,000 are killed by it in 15 seconds, repeated laboratory tests show. Yet Listerine is so safe that it may be used full strength in any body cavity.

Use Listerine systematically during winter weather. It is a pleasant habit, a cleanly habit, and one that may lengthen your life. Lambert Pharmacal Company, St. Louis, Mo., U. S. A.

TO PREVENT COLDS

Colds are often caused by germs transferred from the hands to food which then enters the mouth. Rinsing the hands with Listerine before each meal kills such germs. State Health Boards recommend similar measures particularly during epidemics of influenza.

KILLS 200,000,000 GERMS IN 15 SECONDS

Popular Science MONTHLY

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From Theory to Fact

IN THE leading article of this issue Dr. E. E. Free tells the story of important experiments and discoveries which give promise of removing many of the controversial uncertainties surrounding the theory of evolution.

In the seventy years since Charles Darwin published his *Origin of Species* and startled the world with his revolutionary theory of how life evolved from lower to higher forms, scientists have searched in vain for the cause of the mutations, or changes in character, whose processes through the ages have created mankind.

Now comes a likely answer, in experiments indicating that radium and X-rays can produce marked changes in a species from one generation to the next, and in the well-considered theory advanced by eminent scientists that these rays, as well as the cosmic rays from outer space, may actually be the cause and motive power of evolution.

This new conception of life—that it evolves in response to penetrating baths of energy from the Unknown—marks a profound advance in scientific thought concerning the origin and destiny of man. More than that, if the evidence of recent experiments is established, it may mean that the whole doctrine of evolution itself will evolve.

Evolution will cease to be a disputed theory. It will become a demonstrable fact.

Let the Deaf Hear, Too!

WHAT good is a talking movie to a deaf man?

People with poor ears, yet not so deaf that they have had to learn lip reading, certainly have been dealt a foul blow by the latest form of canned entertainment. The silent drama, decked out with a brand-new voice, becomes meaningless without the usual captions, and a large class of people, already heavily handicapped, now are worse off than ever.

However, the situation is far from hopeless. In fact, a cheap and simple remedy is at hand. The electrical impulses used to operate the stage loudspeaker can be wired to convenient jacks so that any person not stone deaf can plug in his own radio headphones, adjust the volume control to suit himself, and enjoy a talkie as well as his more fortunate neighbor. A similar idea already has been tried out in the Paramount Theater, Brooklyn, N. Y.

And think how perfectly a pair of "earmuffs" can shut out the jabber of the nearby pest who insists on talking continually!

The New Calendar by 1933?

THE first of January, 1933, will fall on a Sunday. That will be an ideal time to put into effect the proposed thirteen-month calendar advocated by George Eastman, of Rochester, N. Y., (P. S. M., June '29, p. 32) and "preponderantly favored," according to the national committee on calendar simplification, by public opinion in this country.

Should the reform fail of adoption at that date, the new calendar may have to wait until 1939, the next convenient year for starting it. For that reason the national committee, in a recent report to Secretary of State Stimson, recommended immediate international discussion of the proposed change to arrive at an agreement for its introduction by 1933.

This reform is a sensible and a needed one. Much as people are accustomed by habit to the present calendar, it is eminently unsatisfactory. Its chief objections, summarized in the report, are these: Months are of unequal lengths and contain unequal numbers of working days, complicating statistical comparison of one month's commercial and scientific achievements with those of another. The months do not contain an equal number of weeks, creating the awkward situation of four pay days in some months and five in others. The days of the week shift each year to different dates, so that the dates of periodical events such as Election Day, and other legal and religious holidays, are constantly changing. The new calendar would solve all these difficulties by substituting thirteen months of exactly four weeks each, and celebrating the odd 365th day as "Peace Day" or "Year Day," an international holiday.

Sentiment abroad, as well as here, seems to favor the change, and it is to be hoped that a world conference will ratify the plan soon enough to make it effective by 1933. Incidentally, this step, if carried out, will be a monument to international coöperation. It is one of the first nonpolitical projects ever to be submitted for unified action to the people of the world.

The Road to Success in Aviation

A THREE-YEAR night course in aviation engineering has just been announced by New York University. As preparation, "a high school education is desirable but applicants with less preparation but greater practical experience will be accepted."

Pointed criticism aimed by factory executives at graduates of various educational courses in aircraft has stressed their lack of "horse sense." Today, by working in a factory by day and studying by night, it is possible to combine practical experience with the very necessary theoretical knowledge that makes for advancement.

In this issue Sherman M. Fairchild, one of America's foremost builders of airplanes, tells of the part that the airplane factory plays in the making of men for the aircraft industry. Himself a college man, he pounds home the fact that only by the combination of theory and practice can a man fit himself for the big jobs of aviation.

They Are Saying—

"THE *Graf Zeppelin* is making a constant contribution to the development of the art of air transportation."—President Hoover.

"The magnetic forces of the world still remain the most baffling of all of Nature's mysteries."—F. P. Ulrich, director of the magnetic and seismological observatory, Sitka, Alaska.

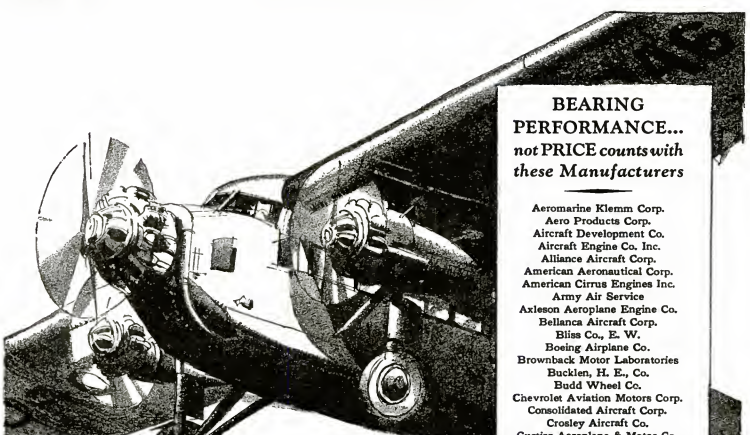
"No other age except this machine age has attempted so high a standard for so many people. There is more emphasis now than ever before on character in the worker."—Dr. Arthur D. Little, famous chemical engineer.

"I was a poor pilot when I crossed the English Channel."—Louis Bleriot.

"The New Yorker is a product of noise. Soldiers get war shell-shock; New Yorkers get peace shell-shock."—Dr. Arthur P. Payne, consulting psychologist, College of the City of New York.

"Were it not for the very great improvements in electric power and electric lighting during the last twenty-five years, the bill which the public is now paying for electric current would be greater by more than two billion dollars a year."—General John J. Carty, vice president of the American Telephone and Telegraph Company.

"The public uses electric radio receiving sets 160 percent more than they used battery receiving sets."—Harold A. La Fount, Radio Commissioner of the Fifth Zone.



What's *a mere matter of* PRICE *when you're a mile or two* UP

IN this new industry of the skies where progress depends upon unfailing performance and dependability and where low price is not a lure, "the highest priced bearing in the world" is used by practically all aircraft and aircraft equipment manufacturers... Aircraft manufacturers can't afford to take a chance on anti-friction bearings. Neither can manufacturers in other fields. They merely *think* they can. Nothing is apt to cost so much as a bearing that cost so little.

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Lycoming Mfg. Co.
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Michigan Screw Co.
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Packard Motor Car Co.
Pitcairn Aviation, Inc.
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Rinehart Whelan Co.
Rocky Mountain Steel Products
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Sikorsky Mfg. Co.
Sperry Gyroscope Co.
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2347

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means protection from the ills and discomforts of cold weather . . . . plus smaller fuel bills

. . . So plan *now* to repair or remodel your home with Celotex, the *only* cane-fibre insulation.

Roofs insulated with Celotex *retard* furnace-heat-leakage . . . *protect* the entire house from penetrating dampness and chill.

Waste spaces in the attic and basement, when lined with Celotex, are changed into delightful nurseries and playrooms; open porches are transformed into sun rooms, enjoyable all seasons of the year.

No other material seems to provide insulating efficiency and structural strength *together* quite so well as cane-fibre.

These fibres — long, tough and durable—interlace perfectly into big, strong boards, 7 to 12 feet long, 7/16 inch thick, also made "double thick"—7/8 inch.

And they contain millions of tiny sealed air cells . . . just what is needed for dependable insulation.

When used on the outside of houses, as sheathing, Celotex adds structural strength . . . makes walls tight and permanent.

And on inside walls and ceilings, you can obtain finer, smoother plastered surfaces with Celotex Lath. This better lath, 18 inches by 48 inches and 7/16 of an inch thick, also made "double thick"—7/8 inch, is especially designed to reinforce against plaster cracks and eliminate lath marks.

Before you build, buy or remodel, ask your architect, builder or dealer for further information on Celotex—and write us for our free booklet, "Year 'Round Comfort and Fuel Saving for Every Home."

The Celotex Company, Chicago, Illinois. [Member of the Home Modernizing Bureau of the National Building Industries, Inc.] In Canada: Alexander Murray & Co., Ltd., Montreal. Sales distributors throughout the world. Reliable dealers can supply Celotex Standard Building Board and Celotex Lath.

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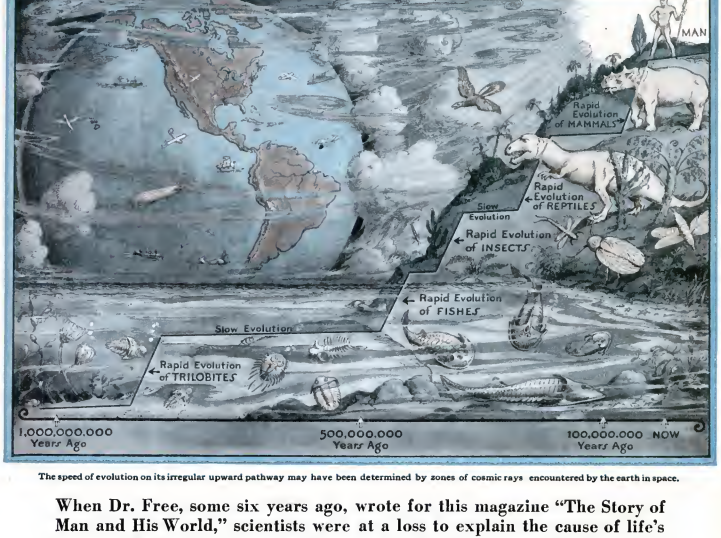
INSULATING CANE BOARD
When you buy a new house, look for the Celotex sign. It is your assurance of greater home comfort.

BE SURE IT'S CANE-FIBRE INSULATION!
Only Celotex is made from the long, tough fibres of cane. The peculiar advantages of cane-fibre insulation cannot be obtained in any other material. Be sure you get CELOTEX!

Popular Science MONTHLY

NOVEMBER, 1929 TRAVIS HOKE *Editor* VOL. 115, NO. 5

Rays—The Clue to Evolution



The speed of evolution on its irregular upward pathway may have been determined by zones of cosmic rays encountered by the earth in space.

When Dr. Free, some six years ago, wrote for this magazine "The Story of Man and His World," scientists were at a loss to explain the cause of life's progress through the ages. Now comes a sequel to the story—the discovery that rays like those which help to cure cancer may also supply motive power in creating new forms of living creatures. Dr. Free here reports evidence of that discovery, which promises as great a revolution in scientific ideas of human development as did Darwin's original theory.

By E. E. FREE

A FEW years ago all that it was possible to say about evolution was that it had happened. Buried in the earth's rocks were clear evidences of the past history of life. In vestige organs like the human appendix; in the results of biochemical blood tests; from a thousand other signposts here and there in the sciences of botany, zoology, physiology, and psychology, it was possible to read the fact of man's animal origin. But the causes back of that vast panorama of evolving life were unguessed.

Now comes for the first time a reasonable theory. Within two years the evidence for it has piled up enormously. Scarcely a month now passes without some scientific man adding new facts to strengthen the argument. The theory is that rays like those from radium are among the causes of evolution—if not its sole cause.

The mysterious cosmic rays from outer space, recently the subject of notable investigations by Dr. Robert A. Millikan (P. S. M., July '28, p. 13), seem to have an important place in the picture, as do

To handle radium safely the worker is shielded behind a thick plate of lead which stops the potent rays. A plate of lead glass similarly protects his face.

some kinds of X-rays. It is not too much to say that this new radiation theory of evolution promises to alter the ideas of science about the history of life on earth as much as did the famous theories of Charles Darwin.

First inklings of the new theory came two years ago when Professor H. J. Muller, of the University of Texas, discovered that treatment with X-rays causes the fruit fly, already a familiar insect for laboratory experiments, to produce new varieties of offspring (P. S. M., Dec. '27, p. 53). This was science's first clear example of evolution produced artificially.

A LITTLE later Professor T. H. Goodspeed, of the University of California, produced new kinds of tobacco plants by treating parent plants with these same X-rays. The rays emitted continually by radium, fundamentally much like the more penetrating kinds of X-rays, have been found to have similar effects.

Only a few weeks ago two research workers at the University of California, Professor Ernest B. Babcock and Professor J. L. Collins, created still other new varieties of fruit flies like those studied by Professor Muller by allowing the parent insects to breed inside a tunnel beneath the city of San Francisco, where the natural radioactivity of the rocks is exceptionally high, so that the flies were exposed to an unusual intensity of radium rays.

Still more recently, two distinguished scientists of Dublin, Ireland, Professor John Joly and Professor Henry H. Dixon, made other startling suggestions. Professor Joly advanced the theory that the cosmic rays which continually bombard the earth from outer space, and which are also much like radium rays, may be mankind's only safeguard against being killed off by cancer. And Professor Dixon added that these same cosmic rays may have provided the motive power for life's evolution in the past.

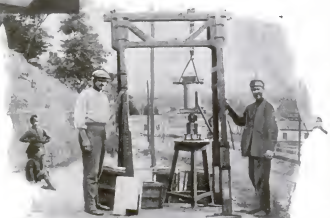
The essential of evolution, biologists have long understood, is not the outward change which geologists trace as elephants evolved, for example, out of a primitive kind of pig, or as the ancient monkeylike creatures evolved into modern apes and man. It is something far more fundamental that takes place within the mysterious "germ plasm" which is the living link between one generation and the next.

All men or women, all modern animals, even the majority of lower animals and of plants, grow from fertilized egg cells, the inmost substance of which is derived from the parents. Close to the center of any ordinary living cell, buried in the living matter or protoplasm, microscopists discern a tiny, darker colored, slightly solider speck. This is the cell's nucleus, which undoubtedly contains the living mechanism controlling a cell, much as a man's brain controls his body. Somewhere within the microscopic nuclei inside the billions of living cells of the human body lies the very secret of life.

IN CERTAIN conditions of living cells, especially of the special germ cells which are the carriers of heredity, it is possible to see still inside the nucleus small dark objects, some almost round, others slightly elongated like a tiny Frankfurter sausage. Biologists call these objects "chromosomes," which means merely "colored bodies," for the tiny particles stain a little darker than the rest of the cell when the usual dyes are applied to make visible the cells' almost transparent interiors. When the chromosomes were first seen by pioneer microscopists no one knew what they were. Now it is known that they are the machinery of heredity.

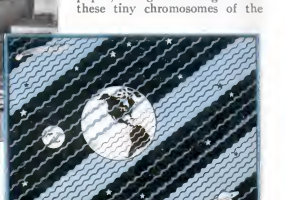
When an egg cell or a sperm cell is being formed in the parent creature, so that a member of the new generation presently may come into being, remarkable things happen to the chromosomes. Those of the parent cell each split apart along their lengths, so that each half possesses a little of every part of the original chromosome. Then other complicated changes take place, both in the female egg cell and the male sperm cell. After these two fuse to make the fertilized egg cell, the new cell is found to have acquired half its set of chromosomes from the mother parent, the other half from the father. That is how the heredity from the two sides is fused.

Thanks chiefly to investigations carried out for years at Columbia University by Professor Thomas H. Morgan and his pupils, biologists now agree that these tiny chromosomes of the



Dr. L. N. Bogojavlensky (left) with the apparatus he used in measuring radioactivity of rocks in different parts of Russia.

At the left is Dr. Robert A. Millikan, of the California Institute of Technology, with the electroscope used in detecting cosmic rays from space. Dr. Millikan is removing from the instrument lead shields which keep it from registering local radium rays and make it responsive to the more penetrating cosmic rays. Final tests were made by sinking this instrument into the waters of a mountain lake to further shield it from earthly rays.



PERHAPS VARIATIONS IN THE INTENSITY OF COSMIC RAYS CAUSED SLOW AND RAPID PERIODS OF EVOLUTION

germ cells carry what might be called a set of blueprints for the new creature that is to be built.

Imagine an architect drawing the plans for a house, for example, on many small round, paper disks, like stoppers for milk bottles. Imagine these disks strung together so that each hundred or so made a sausage-shaped lump. That is about what biologists imagine to exist, on a minute scale, inside the chromosomes.

Part way along the length of one of the human chromosomes, for example, may be a tiny living disk which carries Nature's blueprint for the length of one's nose. If a son inherits that disk accurately from his father, and if the father has a long nose, the son too, will develop that kind of a facial ornament; just as the famous Hapsburg family of European royalty did for generations. Somewhere else along one of the chromosomes will be a disk which carries the blueprints for the color of the hair, and so on.

MANY facts about how the sets of living blueprints are duplicated, transferred, and corrected, if necessary, in the process of heredity, are still among the biological mysteries. But no biologist now doubts that something of this kind is the secret of all kinds of biological inheritance, whether it is that which makes a boy look or talk like his father or whether it be the more obvious kind of inheritance which makes each animal species reproduce itself more or less accurately from one generation to another.

The needs of evolution include, however, something more than inheritance. One of them is what naturalists call variation. If inheritance were absolutely perfect, so that all of a person's children were always exact copies of himself, evolution would not be possible. The world would still be populated by only one kind of creature, all precise duplicates of the original creation.

Fortunately there is variety on earth, and therefore progress. The reason is that each new generation is not quite an exact copy of the preceding one. The blueprints are passed on, true enough, so that the offspring are similar, but experience or environment acts somehow as a correcting and improving architect, to alter the living blueprints slightly and try out some new possibility. The Hapsburg family, for example, was not condemned to go on forever having long noses.

Biologists have always been puzzled, however, about what causes the variations. A first clue to the answer was the discovery of Professor Muller with X-rays. He found that when fruit flies were exposed to these powerful radiations totally new races of flies appeared longer or shorter in wing, differently colored and varying from the former racial standards in other ways.

Not all of these X-ray creations were fortunate ones. Sometimes the evolution thus worked was bad for the fruit flies' survival, instead of good. But what instantly attracted the attention of the world's biologists was that *some* change had occurred. The potent pencil of the X-rays had reached into a set of the architect's plans for the next generation and had changed them, so that a new, different creature was built.

Since then other investigators have confirmed the discovery with the same species of flies; Professor Goodspeed has done so with his tobacco plants; Professors Babcock and Collins have found similar effects from radium rays. They agree that all three kinds of rays—X-rays, the radium rays, and probably the cosmic rays of space—actually can affect evolution.

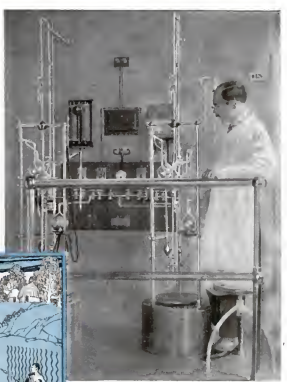
What the rays create in the new generation seem to be the sudden changes which plant breeders call "sports." Biologists call them mutations. From the work of the Dutch botanist Dr. Hugo de Vries, the American biologist Dr. D. T. MacDougal, and others, it has long been believed that evolution in Nature proceeds in this way by relatively sudden jumps from an old character to a new one; from black hair, for example, to red; from the flabby body of the first spineless sea worms to the first beginning of the stiffening rod down the back which was to grow by later mutations into man's backbone.

Professor Henry H. Dixon, biologist of the University of Dublin, who suggests that variations of the cosmic rays may have provided the motive power of evolution.

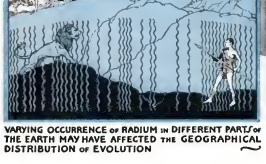
The fact that all three kinds of rays seem to have this same effect in speeding evolution is not surprising. They differ only in that some are slightly shorter in wave length than the others. All three lie at the extreme short end of the whole known series of ether waves. Light waves, themselves far shorter in wave length than the very long radio waves, are followed, as still shorter companions, by the invisible ultra violet rays now much used in medicine. Next shorter than the ultra-violet rays come the X-rays and beyond them the radium rays and the cosmic rays.

THE similar effects of these rays on evolution is paralleled, too, by the similar action of two of them, the X-rays and radium rays, on cancer.

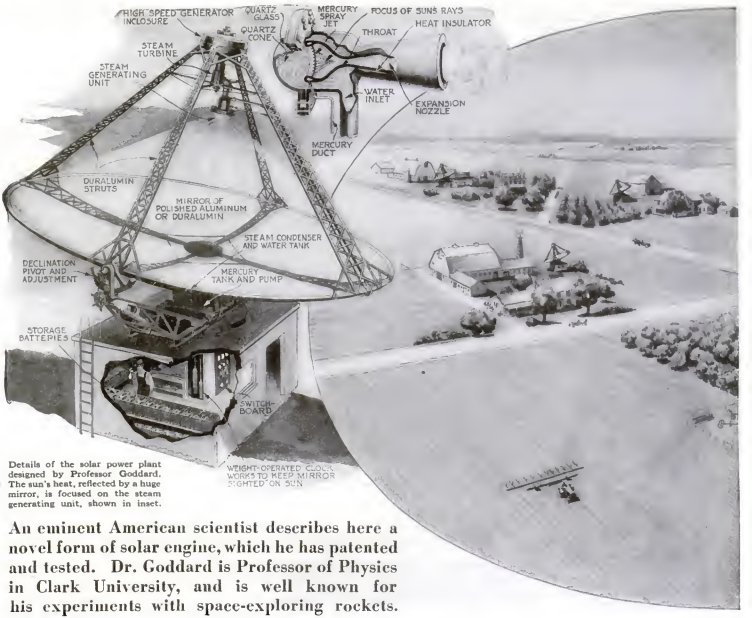
A few years ago the only known cure for cancer was the surgeon's knife. A cancer grows when, for some unknown reason, a few living cells of the body go wrong and start uncontrolled growth. Many normal body cells are able to grow and multiply to some extent when necessary; as skin cells do, for example, when new skin needs to be produced to heal a cut finger. In normal cases such growth stops automatically as soon as it has gone far enough for the body's needs. In a cancer it does not stop. The abnormal cancer cells, escaped from the ordinary bodily controls, keep on growing and multiplying indefinitely. After a while they press on nerves and cause pain, or on essential (*Continued on page 146*)



A modern way of using radium to treat cancer employs radioactive gas which is given off by the radium and which, in turn, emits the curative rays. The radioactive gas is collected in glass apparatus, shown above, and carefully sealed against the air. A dose of the gas is placed in tiny hollow capsules for insertion in the cancer. Many cancer patients now are saved by radium.



VARYING OCCURRENCE OF RADIUM IN DIFFERENT PARTS OF THE EARTH MAY HAVE AFFECTED THE GEOGRAPHICAL DISTRIBUTION OF EVOLUTION



Details of the solar power plant designed by Professor Goddard. The sun's heat, reflected by a huge mirror, is focused on the steam generating unit, shown in inset.

An eminent American scientist describes here a novel form of solar engine, which he has patented and tested. Dr. Goddard is Professor of Physics in Clark University, and is well known for his experiments with space-exploring rockets.

A New Invention to Harness the Sun

By R. H. GODDARD

THE ordinary back yard receives more power in the form of heat from the sun than is used to heat and light the average home. A good-sized pasture may receive power equivalent to that used by all the factories of a town. Great deserts like the Sahara or the Tackla Mahan receive more heat power than is required to warm the dwellings, light the streets, and drive the machinery of all the civilized countries in the world combined.

Throughout the ages, attempts have been made to convert sunlight into mechanical power, but with little success. In every case the apparatus has proved inefficient. At last, the writer is firmly convinced, the problem will be solved by the practical application of a new solar motor he has invented and patented.

According to figures computed by Dr. Charles G. Abbot, director of the Smithsonian Institution in Washington, the sun every day supplies to the earth energy equivalent to the burning of 507,000,000,000 tons of coal. The world actually uses coal, oil, water power, and other sources of energy equivalent to about 5,000,000 tons of coal daily. Time and money are being spent in huge quantities to dig coal from mines, to pump oil from wells, and to harness streams for power, when more than a hundred thousand times as much power constantly is being delivered free right on the earth's surface.

While some of this solar energy is reflected back into space, it has been calculated that one square yard of the earth's surface exposed to a summer sun directly overhead receives energy at the rate of at least one and one half horsepower.

So far, the most successful attempt to harness the sun's power has been the fifty-boiler-horsepower Shumann solar plant at Cairo, Egypt. It turns into useful power only a little more than four percent of the energy received in the form of radiation. Another, the Eaneas solar engine installed at Pasadena, Calif., is even less efficient.

My new solar motor will reach an overall efficiency of at least fifty percent—more than twice that of the finest steam turbine electric generating plant in operation today.

The accompanying illustrations show how this new solar motor might be practically applied to supply power, light, and heat on the farms. The essential features are shown in the broken-away drawings above. Instead of the usual kind of boiler, a hemispherical end piece, made of clear fused quartz, is bolted to a hollow body. Water is pumped in and mercury under high pressure is sprayed into the water as indicated.

The fused quartz, a rock crystal material, recently has been made available in quantity. Its advantages for use in a sun motor are that it is one of the most

How solar motors might be applied to supply power, light, and heat on the farms, as suggested by Professor Goddard. Drawn for Popular Science Monthly by B. G. Seielstad.

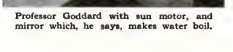
transparent materials known; it will not crack when subjected to heat as does ordinary glass, and it will stand enormous temperatures before it melts.

A mirror of large size is focused on the fused quartz so that the point of greatest heat is where the spray of mercury forms a screen in the water. The water itself, being transparent, will not absorb the heat, but the mixture, being opaque to light, will absorb all the heat instantly. The resulting tremendously high temperature will convert the metallic mercury into mercury vapor at a correspondingly high pressure, and the water will be converted into steam at high pressure. By feeding these gases directly into a turbine, the heat can be converted into mechanical power without the usual losses caused by friction through long sections of piping.

IN A nutshell, the new solar engine is like a hollow crystal ball into which water passes at one end and from which steam issues directly into a turbine.

A feature of the design is that the quartz end piece can be shaped so that every ray of light from the mirror will strike it at right angles. This will prevent loss of energy by reflection. Another advantage is that the hottest point is inside instead of outside, as with the ordinary boiler. This permits the use of a metal lighter than iron for the shell, for the incoming water keeps the metal at a relatively low temperature. Because the hottest point is inside and is surrounded by the incoming water, what heat is lost from the focus point by conduction will serve to pre-heat the incoming water.

A close-up view showing steam, generated by the sun, escaping from Goddard's motor.



Professor Goddard with sun motor, and mirror which, he says, makes water boil.

TO TEST the fundamental principle of the new engine a hollow sphere of glass five eighths of an inch in diameter was filled with water containing finely divided carbon in place of the mercury spray for the absorption of heat. This sphere was placed at the focus of a parabolic mirror one foot in diameter. When the mirror was placed in sunlight, the water boiled easily, the steam escaping in a powerful blast through a hole in the top of the sphere. As water boiled away, more was supplied by a hand pump. This small model will produce steam indefinitely as long as it is supplied with water.

The possibilities awaiting the commercial development of a really efficient solar motor are enormous. There is solid scientific backing for the belief that a solar motor of the size illustrated would produce upwards of thirty useful horsepower when operating under a clear sky between the hours of ten in the morning and three in the afternoon—the time when sunlight is at its maximum power in the United States. That amount of power, converted into electrical energy, would far exceed the requirements of a large farm; the unused current could be employed to charge batteries. These, in turn, could maintain the normal current supply on cloudy days and at night. If the mirror were 100 feet in diameter, the output, figured conservatively, would be 650 horsepower.

NOT everywhere on earth, of course, does the sun shine every day, and in no spot does it remain directly overhead. But even so, it is fair to assume that each twenty-foot mirror concentrating available sunlight on an engine fifty percent efficient would yield, year in and year out, a twenty-four-hour average of at least four horsepower. In sunny tropical regions, such as the Sahara, the average yield would be much greater. Whether to use a large number of such small mirrors or a smaller number of large mirrors measuring a hundred feet or more in diameter, would be merely a question of ease of handling and of comparative cost.

The reasons why the new solar motor will operate with such remarkable efficiency are best understood by observing where the losses occur in present engines such as the steam turbine plant and the gasoline engine.

The secret of efficient operation of any heat engine is high temperature. That is why the gasoline engine, with its extremely hot exploding charge, is more efficient than the ordinary steam engine. That also is why engineers are designing steam plants to use higher and higher boiler pressures. Modern steam generating plants commonly use boiler pressures as high as 500 to 750 pounds, whereas steam plants built years ago rarely used a pressure above 150 pounds.

But the (Continued on page 157)

Walking the *Graf Zeppelin* into its home port hangar at Friedrichshafen, Germany, at the end of its epochal voyage around the world, completed in 20 days and 4 hours. The average speed was 67 miles an hour; actual flying time 13½ days.

The great dirigible floating above Seville, Spain, in the course of a tour over southern Europe a few months before the record-breaking voyage around the world.

Around *the* World *by* Zeppelin

Anchoring the *Graf's* nose to the mooring mast at Los Angeles, Calif., at the end of the first nonstop flight across the Pacific, completed in 78 hours, 58 minutes. On the take-off next morning the ship was slightly damaged.

Looking down from the Zeppelin's cabin upon Wolodga, Siberia, during the long flight from Friedrichshafen to Tokio, Japan.

Over the Pacific—one of the officers using a sextant to determine the position of the huge airship. A violent electrical storm threatened the ship on this leg of the flight.

Crowds in Tokio welcoming the *Graf Zeppelin* to its hangar after the nonstop flight of 6,800 miles from Germany. The ship was in the air 101 hours and 58 minutes. Damages during the take-off the next day delayed the *Graf* 35 hours.

Back again above New York City after circling the globe. This aerial view shows the dirigible saluting the Statue of Liberty to which it had said good-bye just 21 days, 7 hours, and 33 minutes before. The *Graf* broke the previous round-the-world record by 2 days, 7 hours, and 48 minutes. Magellan's world voyage, completed in 1522, required 3 years and 29 days. After this photo was taken, the dirigible sailed back to Germany.

Camille Flammarion, noted French astronomer, who was one of the first to suspect the existence of a cloud of atomic dust pervading space. The photo shows him in his remarkable museum near Paris.

"Empty Space" a Cloud of Dust

By THOMAS ELWAY

ASTRONOMERS once talked much about "empty space"—cold, dark, and limitless—between the solar system and the stars. Now that phrase is known for a fundamental mistake. Space is not empty. Stretching between the earth and the farthest confines of the known universe, so far away that light rays traveling 186,284 miles a second need more than a hundred million years for the journey, there extends, it now seems certain, a kind of thin space-gas composed of atoms flying about violently, knocking against each other, constituting something entirely new in the scientists' knowledge of the universe.

A few weeks ago at the meeting of the British Association for the Advancement of Science in South Africa, the distinguished astronomer of Cambridge University, Professor A. S. Eddington, discussed this cloud of space atoms. It probably contains, he said, more than half as much matter as is contained in all the millions of stars. About a third of all the atoms in the universe are in the space cloud; more than a hundred billion billion times as much matter as goes to make up the earth. Yet the space cloud is so thin that it stops almost none of the light from stars a hundred million light years away. It has a temperature, Professor Eddington indicates, of perhaps 30,000 degrees F., yet it would not so much as warm the hand. Altogether, it is one of the most remarkable and paradoxical objects that astronomy has discovered.

Many years ago Sir William Herschel, Camille Flammarion, and other astronomers suspected some such space cloud, but could not prove it. Only in 1923 did Dr. J. S. Plaskett of the official Canadian observatory in British Columbia obtain the first actual trace of the space dust. Certain dark lines across the rainbow-strip or spectrum of distant stars indicated, he decided, the presence in space of a cloud of atoms of calcium, the chemical element of lime. Since then Dr. Otto Struve and others have confirmed this fact and have proved the existence, side by side with these calcium atoms, of space atoms of sodium, the element of common salt. All kinds of atoms present on earth are believed to be present, too, in the space cloud, each in its proper chemical proportion. But it is only those of calcium and sodium which the astronomers have been able to detect directly.

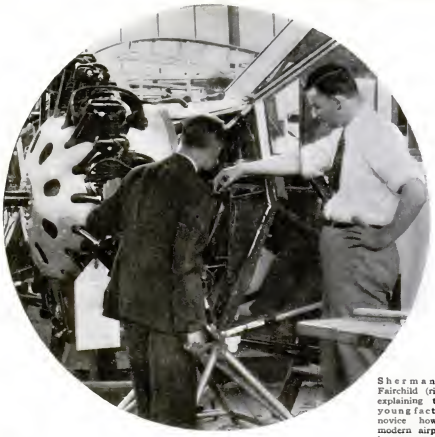
Spiral nebula M.101—one of some 300,000 gigantic star clouds whirling like pinwheels in the known universe. The earth is part of one.

Years ago the great American photographer of the heavens, Dr. Edward E. Barnard, photographed more than 300 dark objects in the skies, the so-called dark nebulas. One of these, nicknamed the "coal sack," looks like a hole in the thickly sprinkled star field of the Milky Way. It is not a hole, but a cloud of some kind of matter, sufficiently opaque to shut off the rays of stars behind it.

The Dark Bay in nebula south of Zeta Orionis looks like a hole in the sea of stars. It actually is a dark cloud of matter hiding the light of stars behind it.

Dr. Barnard's photographs proved that dark matter can exist in the universe, but these dark nebulas are not quite like the newly-discovered dust cloud. The opaque cloud that makes the coal sack is far thicker, undoubtedly, than the average of the dust in space. It is some kind of local accumulation, like a dust cloud in the earth's air.

Doctor Struve has calculated the number of stray atoms in the space cloud and their density in an average cubic mile of space. This last is far less than the density of the gas still left in the most perfect vacuum ever produced by man. Imagine all the air pumped away from above the United States. (*Continued on page 166*)



Sherman M. Fairchild (right) explaining to a young factory novice how a modern airplane is put together.

You Don't Have to Be a Pilot—

At the age of thirty-three, the author of this article is one of America's leading airplane manufacturers, and inventor of the aerial camera which bears his name. From his own experiences he tells here of the many opportunities, beyond actually flying a plane, which await the young man who is ambitious for a career in aviation. He himself began as a nonpilot, and by resourcefulness and industry reached a place at the top.

By SHERMAN M. FAIRCHILD

DURING the high pressure days of war preparation, the United States Air Services examined more than 250,000 applicants for training as pilots. Of these, 20,000 were passed as being fit for training, or less than one out of twelve. And of the 20,000, only 4,000 were commissioned as officer pilots, or one out of 62.5. The Air Services were taking only the best.

Sixty-five thousand applicants and only sixty-five hundred pilots to date. One out of ten. That is the three-year record of licenses issued by the Department of Commerce's Aeronautics Branch. Most of those who failed to qualify had bad eyes. Some had high blood pressure, or lack of heart reserve. Some lacked muscular-mental coördination. Others had no acute sense of balance. Any one of these defects ruled them out of a pilot's job. What does aviation offer them?

Opportunity and romance. You don't have to be a pilot. You can be, for example, an operations mechanic and help run an airline, just as the trained engine and car mechanics help conduct a railroad. Or if your hobby is radio, you may indulge in it in the air as well as on the ground. Picture-takers may become aerial photographers. As a novice mechanic you can earn twenty-five dollars a week; as a master mechanic one hundred and fifteen dollars or more. Then there are possibilities of becoming an aeronautical engineer at a salary as high as $12,000 a year.

ALL the thrills in aviation are not reserved for pilots. Consider the recent experience of Lieutenant Ivonnet over Le Bourget Field, near Paris. Ivonnet, a nonflyer, was in a plane as observer. The pilot was stunting, and fell out while performing a difficult maneuver. He opened his parachute and dropped safely to earth. But Ivonnet had no parachute. He could only seize his side of the plane's dual control and do what he thought best. Fortunately, he had been associated with flying long enough for pilot friends to have given him some air work. He sailed over the ambulances and fire engines waiting for him on the field and crashed in a creek nearby. Luckily, he escaped without a scratch—but he had experienced thrills enough for a lifetime.

Think of the mechanics who are in the Antarctic with Commander Byrd—think also of those who travelled on the epochal army flights to Alaska and around the world—think again of those who groom the airplanes that fly the mail runs. For romance right at home, take the chief mechanics, and their crews or their staffs on runs over large airline divisions. They are responsible for the inspection and servicing that prepares fast planes for their important missions all over the country. These planes carry passengers, mail, diamonds, nitroglycerine, negotiable securities, specie—all the varied things that go to make up the air traffic. All the thrills of 100 percent operation are not for the pilots alone.

How can a young man get into this side of aviation? By way of the airplane factory. That, I think, is the world's best introduction to a steady, paying job of the nonpiloting sort.

Even a young high school graduate who has had no experience whatever with airplanes can find a place in an airplane factory, provided he is willing to start at a small salary and work his way slowly up. He starts in as a mechanic's helper, at thirty to forty-five cents an hour. If his first work places him in the assembly department of a factory, he may perform such a simple task as putting small parts on planes. Or he may commence as a welder's helper, or a sheet metal worker's helper, or a helper in making wing ribs or beams.

"EXPERIENCED men need not apply" is the slogan of many welding departments, our own included. Veteran welders from any other field than aviation seem unwilling to learn the special methods that airplane welding demands. Wrapping a blowtorch flame around a tube of chrome-molybdenum steel only thirty-five thousandths of an inch in thickness differs considerably from welding a boiler or a section of gas main. In consequence, we prefer to take an inexperienced man and teach him our methods from the start. He practices on minor and less important work first. After an unfixed period he is allowed to work upon important structural elements.

One man doing that now in our factory was sent over by the Japanese Government to learn our methods. He came to

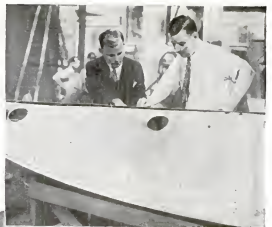
learn in the belief that American methods were the best and offered the most varied application of the art. Another of our men learning welding was a stowaway on the Byrd expedition. He returned about a month ago on the Eleanor Bolling, came here, and obtained a position. "They need another good welder in the Antarctic to work on their planes," he says. He is hoping to return when he has qualified as a first class airplane welder. His name is William Gavronsky, and he is a tow-headed Polish boy of eighteen.

Anyone with a natural bent for aviation will make progress naturally. From a mechanic's helper, first, he will become a mechanic, earning seventy-five or eighty cents an hour.

A FACTORY mechanic should not be confused with a Government licensed mechanic. The first is purely a factory worker. The other is an airplane or engine mechanic qualified to work upon any licensed airplane, on any field. Government regulations reserve this privilege to licensed mechanics, except that others may assist them. To obtain a mechanic's license, it is necessary to have two years' experience and to pass a Department of Commerce examination. An airplane factory is the ideal place to obtain the required experience. Once licensed, good mechanics may earn as much as $115 a week. Good airplane and airplane engine mechanics are in great demand. Now that airplane lines are using bigger passenger planes, there is an ever increasing number of jobs as flight mechanics who ride with the pilots on scheduled runs.

In the air a nonpilot may have opportunity to show courage and alertness. Not long ago a Navy observer saved a plane from being wrecked. Perhaps he saved the pilot's life as well. They were flying near Philadelphia. Suddenly the propeller blade snapped. The motor raced, tore itself loose, and dropped off. Nose-light, the plane inclined upward at a dangerous angle. All this happened in a second or two, but the observer in the rear cockpit, L. S. Williams, realized the situation in time for action. He leaped out of the plane, trusting to his parachute. His quick-witted action lightened the rear, and the pilot was able to right the plane. Both pilot and observer landed safely.

Such an example shows that flying sense is not confined to pilots. Anyone who thinks and studies the game is bound to acquire it. The other day a British mechanic, who had never flown a plane in his life, took someone's dare and flew off alone with a big night bomber. He was gone for four hours and Royal Air Force planes went out to look for him or the wreckage. When he was sighted on his way back, they rushed fire apparatus to the landing field, expecting him to crash.



A view of the assembly line in the Fairchild airplane factory, showing men at work on cabins. Top: Making seaplane pontoons, metal structures with water-tight compartments, that are interchangeable, left and right.

Welders start with minor jobs. These novices are practicing on exhaust stacks; fuselages come later.

But he made a safe landing, even if it was obviously inexpert.

If a man stays on at the factory, instead of seeking a position that will take him into the air, he may rise from a mechanic to an assistant foreman, and then a foreman. They receive from forty to sixty dollars a week. During this time an ambitious person will have started to build an unbounded future for himself by successfully completing a night course in drafting, and yet another in engineering.

When he has come to the realization that aviation as a science and airplane structures are in a transitory state, only then will he be fortified to continue study with real enthusiasm and more earnest application. Where he goes from there depends on the individual.

Here a skilled carpenter stands at his bench tapping tiny nails into wing ribs built up of delicate strips of wood. He has been making similar ribs for nine years.

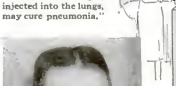
Pumping hot linseed oil through the tubular framework of a fuselage to reveal flaws and prevent corrosion. An inspector, by placing his hand on each member and feeling the warmth, can make sure that the oil has reached every part of the structure.

FEW persons probably have much more than a vague idea just what an aeronautical engineer is or does, excepting possibly that he must deal with very complicated mathematical applications. As a matter of fact, he does. However, there is the extremely practical side, as not all of his work takes him into the realms of higher mathematics. You might say that there are as many kinds of engineers in aeronautical works as there are kinds of engineering.

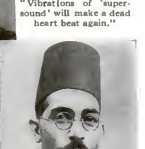
To be a qualified designing engineer is the goal of every aeronautical engineer. Designing engineers are the creative geniuses behind airplane development. They are rare. They are the only ones who dare design a plane that is radically new—with the likelihood of finding that it will fulfill the purpose of the design. Such a man is a composite aerodynamics expert and a (*Continued on page 149*)

Science Takes Stock of Human Machines

Dr. Yandell Henderson, Yale University: "Carbon dioxide gas, injected into the lungs, may cure pneumonia."



Dr. E. Newton Harvey, Princeton University: "Vibrations of 'supersound' will make a dead heart beat again."



Dr. Ali Hassan, Egypt. He is planning one of the world's greatest hospitals, to be erected in Cairo.

Dr. David I. Macht, Johns Hopkins University: "Plants are peculiarly sensitive to poisons of snakes."

Dr. W. R. Hess, of Zurich, Switzerland: "Cats can be put to sleep artificially by the application of electric current to the animal's brain."

A HUMAN heart has been kept alive thirty hours after the body died. Life has been preserved in an isolated head for three hours. "General circulation" has been restored to some extent after apparent death. These facts show that death, long considered inevitable, may be postponed or even abolished, declared Dr. Eusebio A. Hernandez, of the College of France, Paris, who himself has restored the respiration of a presumably dead dog. He proposed an international "death laboratory" where experts will study ways to abolish death and to make human beings more or less immortal. Indeed, a "marked prolongation of life" in certain experimental animals by administration of a gland substance called "inter-renalin" was reported by Drs. J. M. Rogoff and G. N. Stewart, of Cleveland, O.

Suppose human beings should not die? How they might keep young was told by Dr. Serge Voronoff of Paris, internationally known experimenter in rejuvenation through what is popularly known as "monkey gland" technique. For ten years he has observed the effect of grafting animal glands on other animals and on men to restore youth. He reported the results to be improved muscular strength, better appetite, greater brain power for men, and lower blood pressure. Effects of the operation began to wear off during the third year following it and disappeared by the fifth year, he admitted.

Rejuvenation in capsule form was a promise held out by Dr. Casimir Funk, of Paris, discoverer of the first vitamins and coiner of the word. He told of a "hormone" or gland substance which he has isolated for the first time, containing the essence of masculinity. So far it has been applied only to animals with a hypodermic needle, but he is trying to concentrate it in pills for human use. It is the decline in the natural supply of this masculine principle, he claimed, that causes old age.

Conquering Disease

RADIUM made more potent by electric shocks, soda-water "fizz gas" applied to pneumonia patients, and a new way of treating cancer are the latest innovations in the never-ending war against disease.

Experiments in cancer treatment reported by Prof. Boris Sokoloff of the University of Prague, Czecho Slovakia, promise a step forward in learning to fight this dreaded scourge, though they do not yet offer a cure. His new medicine, a mixture of an organic iron compound and pyrrol blue, a coal-tar dye, has been applied successfully, he said, to 200 cancerous rats with cures as high as ninety-three percent. The method of cure was not to poison the cancer cells, but to make them burn themselves up by an overdose of oxygen. Whether the method will work as well on men as on rats has not been determined.

Radium, still the most effective weapon against cancer and certain skin disorders, can be strengthened by electricity, according to Prof. George von Wendt of the University of Helsingfors, Finland. He places a capsule of radium at the tip of an electric wire carrying high-frequency current at 200,000 volts. The strengthened radiation of a tiny pellet that results, he said, reduces considerably the cost of radium treatment. With radium at $50,000 a gram—a gram is about 1/454th of a pound—this scheme should be a boon to poor patients, if more tests sustain the validity of the first experiments. Hitherto scientific men have believed that nothing, not even the most powerful electric currents, could in any way affect the spontaneous action of radium.

CARBON dioxide, the gas that makes the "fizz" in soda water, may save pneumonia victims, according to Drs. Yandell Henderson, H. W. Haggard, and E. M. Radloff, all of Yale University. When this gas, which is the normal waste product of breathing, is injected in quantity in the collapsing lung of a pneumonia patient, it stimulates deep breathing and so expands the lung again. Thus the lung is saved from being filled with fluid, or, if fatal blocking has already begun, it clears up. X-ray photographs show this happening following the application of the gas to dogs suffering from severe collapse of the lungs.

Other diseases are rapidly being conquered. Discovery of a distinctive toxin in the blood of lepers has led to an important method of treatment, according to Dr. David I. Macht, of Johns Hopkins University. Anemia may result from excess stomach acid, declared Dr. W. N. Boldyreff, of Battle Creek, Mich., who found that acids injected into the digestive tracts of dogs destroy red corpuscles in the blood stream. Ultra-violet "health rays" from sunshine arc lamps, whose curative power is claimed to be of benefit for many ills, are of no apparent benefit whatever to anemic patients, Drs. Henry

A THOUSAND physiologists from many parts of the world met in Boston a few weeks ago for the Thirtieth Annual Physiological Congress. Their purpose was to take stock of the new and revolutionary ways in which science is trying to make human beings healthier and happier. Here are presented the high spots of their meeting.

Laurens and Paul C. Foster of New Orleans, La., concluded from experiments with anemic white rats exposed to the rays. But other curative measures for pernicious anemia victims may be started more promptly, Dr. Macht reported, through a new method of diagnosis that tests the effect of the patient's blood upon plant seedlings. It distinguishes immediately between this and other forms of anemia.

How Human Machines Run

THE possibility that some day man may alter his emotions and be happy or sad, whimsical or serious, at will was hinted in the long-awaited findings of Dr. Ivan P. Pavlov, eighty-three-year-old Russian physiologist and Nobel Prize winner.

An example from his twenty-five years of experiment was cited in his "dog-bell" experiment. Noticing that a dog's mouth watered at the mere sight of a juicy beefsteak, the experimenter tried ringing a bell each time the steak appeared. Eventually he found that the dog's mouth watered at the bell's sound alone, even when the steak did not appear. Emotions of hunger or other sensations may be produced in human beings in a somewhat similar way, he suggests.

Remarkable progress in finding what makes a human being's mental and physical "wheels" go around was reported by other experimenters. Still on the trail of emotions, J. F. Fulton and F. D. Ingraham of Oxford University, England, learned that chronic anger in some persons, notably insane patients, was probably due to brain injury. An artificially-produced lesion transformed a normal cat into an angry, spitting creature.

On the physical side, the entire functions of the human factory and power plant came in for new study.

A sprinter uses thirteen horsepower of chemical energy, said Dr. W. O. Fenn, of Rochester, N. Y.; but he develops only three horsepower of mechanical energy. The human machine in other words is about twenty-two percent efficient as a power plant, which compares well with the efficiency of small steam engines.

Balloons swallowed by volunteers helped the study of hunger caused by insulin, a drug used in the treatment of diabetes, in tests described by Professor A. J. Carlson and Dr. P. Quigley, of the University of Chicago. After fasting from fifteen to forty-four hours, the men took their odd meal of small rubber balloons, which were connected with the outside world by slender tubes. Instruments attached to them showed, through a change of pressure, the muscular stomach contractions accompanying hunger.

That the low pressure of air at high altitudes, rather than lack of oxygen, may cause the distress noticed by mountain climbers and aviators was a possibility indicated by Dr. Charles Richet, Jr., of the medical faculty of the University of Paris. A rabbit, placed in a chamber containing plenty of oxygen but with the pressure reduced to correspond to an altitude of 37,500 feet, died after walking two minutes and a half in a revolving drum, he found. So long as it did not exercise, it had survived up to that time. Other animals survived the altitude experiments and died the next day.

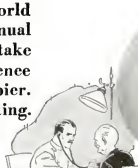
How the human eye sees colors has long been a subject of controversy. Dr. H. H. Roaf, of London, suggested that it may possess "color filters" similar to the tinted pieces of glass used in color photography. He told of finding red, yellow, and almost colorless globules in a hen's eye, in the "cones" or nerve tips of the retina, and said that these may have the function of separating light into its component colors, as in the photographic process.

"Super-sound" waves, mysteriously rapid vibrations too high for the human ear to hear and which kill small fish placed in a tank of liquid, will stimulate a dead heart into action, Dr. E. Newton Harvey, of Princeton University, announced. When he placed a dead heart of a turtle or frog in a glass test tube and subjected it to the vibrations of a quartz crystal, which range from 300,000 to 2,500,000 a second, it began to beat rhythmically once more. The method could not be used to resuscitate a person whose heart had stopped, he said.

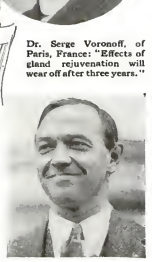
Nerve Flashes Visible

WHEN a man puts his hand on a hot stove, a nerve message races to his brain. It warns him to take his hand away. Somehow the mysterious telegraph message gets there at an estimated speed of 288 miles an hour. But how? Is it an electric or a chemical impulse? No one knows. Discovery of a way to make nerve flashes visible for the first time, and so possibly answer the riddle, was announced by Drs. Joseph Erlanger and H. S. Gasser, of St. Louis, Mo. They used a lightning recorder to do it.

This instrument is known as a "cathode ray oscillograph," used to record (*Continued on page 143*)



Dr. Serge Voronoff, of Paris, France: "Effects of gland rejuvenation will wear off after three years."



Dr. W. O. Fenn, of Rochester, N. Y.: "As a power plant the human machine is about twenty-two percent efficient."

Dr. Ivan P. Pavlov, of Russia: "Man may alter his emotions." (By ringing a dinner bell he has made a dog's mouth water.)

Dr. W. N. Boldyreff, of Battle Creek, Mich.: "Anemia may result from excess stomach acid, which destroys red corpuscles."

Prof. A. V. Hill, London University: "Nerves get hot while carrying a message." He has measured the amount of their heat.

Streamlined like a fish—the *Golden Arrow* in which Maj. H. O. D. Segrave set a world's auto speed record of 231 miles an hour. Compare its lines with those of the submarine on opposite page.

STREAMLINING for SPEED

The largest structure in the world—the new dirigible hangar rising at Akron, O.—will be streamlined. So are the funnels of the world's fastest liner, the SS. *Bremen*. Automobiles, submarines, and motorboats make use of streamline design, as do ocean liners and torpedoes. Streamlining reaches its highest point in the design of airplanes, and even of their smallest parts.

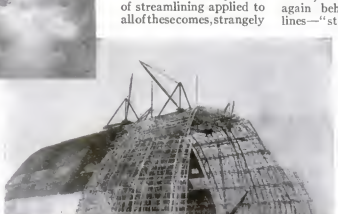
And the basic pattern of streamlining applied to all of these comes, strangely enough, from fish. The secret of a fish's speed under water is the magic touch that gives racing cars and planes their top speed. A fast-swimming mackerel is Nature's excellent attempt at a perfect streamlined object.

There are other examples of streamlining in Nature. Birds and insects are shaped to offer the least resistance to flight through the air. Notable among the insects, for example, is the deer botfly, of North and South America and parts of Europe. It can travel 815 miles an hour, nearly half the speed of a bullet from an Army rifle, and is the fastest living thing.

What does that much-misunderstood word "streamlining" mean? Practically, it is the design of an object so as to offer the least possible resistance to moving water or air or any other fluid. Actually this is accomplished by shaping it so that currents of the moving fluid, be it water or air, meet it, pass around it, and join again behind it in smooth, unbroken lines—"streamlines." Should the currents break into swirling eddies behind the object, it is not "streamlined" and its motion or the wind's around it, is impeded.

A fisherman standing on a bridge can observe the difference. In the swift, rippleless passage of a trout swimming near the surface, he has a beautiful example of applied streamlining. But he has only to look at one of the round piles of the bridge and see the vortex of water swirling in on its downstream side to observe the effects of the absence of streamlining. The fish, moving in the water, encounters a minimum of resistance; on the contrary, the non-streamlined pile quivers with its resistance to the water when the torrent runs strong.

An expert estimates that if the vertical struts of an airplane were round, of the same shape as the bridge pile, they would offer from six to ten times as much resistance to the air as those actually used, which in profile are of a blunt-nosed,



This nine-acre hangar, now being built at Akron, O., to house the Navy's new dirigibles, will be the world's largest streamlined object.

A SPURT of flame, and a projectile shot from the muzzle of a gun mounted in an emplacement at the Petawana, Ontario, military camp. Crash! Another direct hit on the distant target. Visitors watched the gun practice of the Royal Canadian Horse Artillery, the other day, marveling at the accuracy of their fire. Few knew that this was the first test of a remarkable new type of shell, of which a scant three hundred had been made and shipped to the post for a try-out.

But an engineer, inspecting one of the eighteen-pound shells which lay on the ammunition rack, could have told in a moment the reason for its long range and its remarkable accuracy. It was "streamlined," just as airplanes and torpedoes are streamlined, to minimize wind resistance in its speeding flight through the air. Besides the usual tapering nose of ordinary projectiles, its rear end also had a taper that is characteristic of bodies designed to cut through air or water with the least possible disturbance. In this it differed from the conventional type of shell with a flat base.

Only recently have high-speed cameras and fascinating experiments with colored liquids made it possible to understand the principles behind the highly-complicated science of streamlining. Yet it is applied, today, in an amazing diversity of ways, in everything from buildings to the stacks of steamships.

Courtesy Museum of Peaceful Arts

Eddies of air behind an airplane wing tilted at an angle are revealed in the remarkable "slow motion" picture at the left, made by Baron Shiba's new speed camera. These eddies are traced on chart at right.

"What is the proper way to tow a spar?" was a trick question often asked in tests of seamanship. The answer is "Butt first." Landlubbers usually answered "Small end first." In this article are explained other surprising facts revealed by the new science of streamlining, a science of speed learned by man from the fishes.

By ALDEN P. ARMAGNAC

Streamlining takes much the same form in water as in air. Note the likeness between this speeding submarine and the *Golden Arrow*, due to the fact that the two vehicles overcome approximately the same total resistance.

tail-tapered fish shape. Imagine a modern airplane with six to ten times its actual number of struts, and it will form a fair picture of what absence of streamlining would mean.

Streamlining, as applied correctly, is a comparatively new thought in science. Ancient shipbuilders may have learned some streamlining principles through experience, but they did not understand the how and why of the designs they adopted. Until recently the search for a perfect streamline shape faced staggering difficulties. Mathematics was little help. The most expert mathematician could calculate the path of fluid current past only two of the simplest-shaped objects, —those of oval and circular profile—and the path around a flat plate was beyond him.

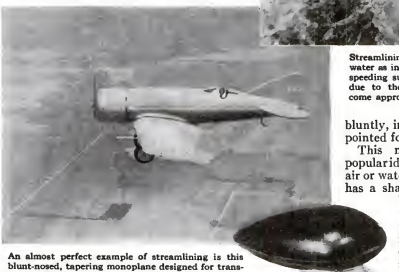
Models of various shapes towed through water and subjected to air currents in wind tunnels gave the hint that a body of least resistance must be tapered to some extent at each end, or, in technical language, "fusiform," a word derived from the same source as "fuselage." Then experimenters conceived the idea of releasing colored fluid in water or blowing smoke past objects of various shapes to find the extent of turbulent eddies behind them. The most successful experiments of this kind were made by immersing a cylinder, say, in a stream of water and injecting into the stream, from a series of holes, filaments of colored fluids. In this way an English experimenter, Dr. H. S. Hele-Shaw, obtained interesting patterns of disturbances behind flat plates and cylinders.

A moving picture camera capable of actually photographing air in motion removed the last uncertainty concerning the behavior of air or water around streamlined and other shapes used in the design of airplanes. This device, invented by Baron C. Shiba, head of the Aeronautical Research Institute of Tokio University, Japan, takes 20,000 pictures a second by a succession of reflections from a revolving steel mirror.

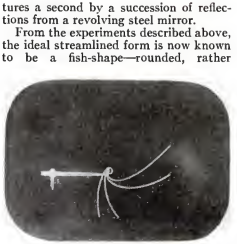
From the experiments described above, the ideal streamlined form is now known to be a fish-shape—rounded, rather bluntly, in front, and tapering to a slim pointed form at the rear.

This may surprise many, for a popular idea is that a body moves through air or water with least resistance when it has a sharp-pointed prow. Actually a blunt front, combined with the tapered stern, is a far better streamlined shape. This is illustrated by a trick question often asked in tests of seamanship: "What is the proper way to tow a spar?" The correct answer is, "Butt first." Old-time seamen knew this, but they didn't know why. A landlubber would usually answer, "Small end first." The truth seems easier to understand when it is noted that the ideal streamlined form turns out to be exactly the shape of the fastest-swimming fish.

Study of how to apply these principles has led to other discoveries. The proportions of a properly streamlined object alter only slightly with the speed of the object and the density of the medium through which it travels; the general shape, not at all. Although water offers more than 700 times as much resistance to a body's passage than air, at normal speed, a streamlined body designed for one is very nearly suitable for the other. A slight change is always purposely made from an ideal form; the tapered stern is foreshortened a little, a compromise between perfect streamlining and the undesirable "skin friction" that takes place when *(Continued on page 162)*



An almost perfect example of streamlining is this blunt-nosed, tapering monoplane designed for transpacific flight. Note the "Venturi cowling" at the front, a recent innovation to cut down wind resistance. Right: Streamlined airplane navigation light.



Courtesy Museum of Peaceful Arts

Vortex of air at the tip of a revolving airplane propeller, photographed by Baron Shiba's camera at a speed of 3,430 pictures a second, and charted at right. The propeller was revolving 57 times a second.

Tying Europe to America by Telephone Wires

How Scientific Research Is Leading a Great Industry to New Triumphs in Long Distance Speech—An Interview with the Chief of the Bell Laboratories

By FRANK PARKER STOCKBRIDGE

TWENTY-FIVE YEARS ago it occurred to officials of the Bell telephone organization that a little scientific research mixed with engineering might help to solve some of the problems of the telephone. It wouldn't do any harm to try, anyway. The company's headquarters were then in Boston, Mass., and the handiest place to look for a young scientific engineer was the Massachusetts Institute of Technology at Cambridge.

They looked there, and picked a young chap named Frank B. Jewett. He seemed to fill the specifications, for he was teaching physics, which is pure science, and electrical engineering, which is an applied science. Business men of 1904 shied away from pure science, but young Jewett seemed a practical sort of a fellow, even though he had won the degree of Ph.D. at the age of twenty-three from Chicago University. The telephone officials gave him the title of Transmission Engineer and the job of trying to make the telephone work over longer circuits.

That had not been Frank Jewett's idea of his own future. His ambition had been to become a mechanical engineer and build locomotives. But few young men in their twenties can guess where they are going to land at fifty.

Today, at fifty, Frank B. Jewett finds himself a Doctor of Science of five great universities, Doctor of Engineering of another, past president of the American Institute of Electrical Engineers and holder of its Edison Medal for his contributions to electrical science, recipient of the Distinguished Service Medal of the United States and of the Order of the Rising Sun from the Mikado of Japan. And if these honors do not spell practical achievement, consider these:

HE IS vice president of the world's largest corporation, the growth of which in the last twenty-five years has been due as much to Frank Jewett's work as to that of any other one man. And he is president of the world's greatest industrial research laboratory, out of which flows under his direction, a never-ending stream of revolutionary inventions and applications of science to industry, particularly in the field of electrical communications.

The corporation is the American Telephone and Telegraph Company, the research workshop, the Bell Telephone Laboratories. Twenty-five years ago, when young Jewett left his teaching job to find ways to make the telephone work better, it was hard to telephone from New York to Boston, almost impossible to talk to St. Louis from Buffalo. Today, as a result of his work, anyone can talk by wire from Montreal to Mexico, or from Portland, Me., to Portland, Ore., almost as easily as to the next room, and by the combination of radio and wire San Francisco can converse readily with Paris, Berlin, or Budapest.

"Tomorrow," Frank Jewett told me, "speaking figuratively as to time, we shall talk *over a wire* from continent to continent. The transatlantic telephone cable has passed out of the laboratory into the workshop, and soon will be laid direct from Newfoundland to Ireland. Over that cable people will talk as easily as they now talk across the continent. I look for that to be placed in operation some time within the next five years."

That intercontinental telephone cable is more revolutionary than it may seem. Electrical engineers call it probably the biggest achievement of the research laboratory which Dr. Jewett heads—a laboratory which, dealing primarily in problems of telephony, has turned out an imposing list of scientific by-products which have found their commercial applications in other fields.

"WITHIN five years," Dr. Jewett says, "people will telephone by wire across the ocean as easily as they now talk across the continent."

The story behind this achievement, called the greatest in the history of the telephone, is told here. It is the story of an extremely practical scientist who gained a commanding place in industry by applying laboratory knowledge to modern needs.

"OUT of our laboratory," said Dr. Jewett, "have come such inventions as the Orthophonic Victrola, electrical recording of phonograph records, talking motion pictures, television, aids to the deaf, measuring apparatus for the medical profession, the artificial larynx, and a host of others, all of which have resulted from our efforts to improve telephone service. Many of our research men have achieved international reputations as the result of some of these by-product applications. All over the world the names of Dr. Harvey Fletcher, Dr. Herbert E. Ives, Dr. O. E. Buckley, Dr. H. D. Arnold, and others of our staff are known to scientists."

It wasn't difficult to get Dr. Jewett to talk about the work of the Bell Telephone Laboratories, or about the scientists who work there under his direction. It was a good deal harder to get him to talk about himself. In his office on the twenty-sixth floor of the Telephone and Telegraph Building in New York, he looks and acts more like a successful business administrator than like the traditional concept of a scientist. He doesn't look his fifty years. His dark eyes glow with the enthusiasm of youth as he talks about the future developments in his chosen field. He chooses his words carefully, speaking with the precision to be expected of a man whose work deals with hard, scientifically-proved facts. Order, neatness, precision are the keynotes of his character. His office itself, his own attire, the feeling of poise and balance which his manner conveys, all prove that. The earmarks are all those of the cultured metropolite. Nothing about him suggests the great open (*Continued on page 161*)

Drawn especially for POPULAR SCIENCE MONTHLY *by B. J. Rosenmeyer*

FRANK B. JEWETT, Master of Telephone Science

President of the Bell Telephone Laboratories and vice president of the American Telephone and Telegraph Company, he has made a vast industry grow and thrive on the products of scientific research.

Planes Pick Odd Ways to Crash

Striking a rut as it was taking off from the Boston Airport with three passengers, this monoplane dove into soft mud bordering the field. No one was badly hurt.

This one plunged into a garage at San Gabriel, Calif. The pilot and a student flyer escaped with slight injuries.

In a forced landing near Huntington Park, Los Angeles, an Army biplane (above) landed on a sedan parked in the street. Flyers and motorist escaped unhurt.

Attempting a landing in a New York City street, the plane at the right coasted into a lamp-post. The pilot climbed out smiling.

A biplane's unexpected call at the summer home of Governor Larson of New Jersey, at Sea Girt. It crashed into his bedroom.

A bath in the surf. Forced down 100 feet from shore at Rockaway Beach, N. Y., Lieut. Richard Alworth was rolled ashore on the breakers unhurt. His plane is shown here being hauled to the beach by a cable.

At the mercy of the winds. Here is the wreck of one of seventeen Navy seaplanes piled up on the shore of the Patapsco River near Baltimore, Md., by a sixty-mile-an-hour gale which swept the Atlantic seaboard.

Since Pilots Can't Always Be Choosers, They Sometimes Come to Strange Landings on Roof Tops, in Trees and Mud—Even on Automobiles

A roof-top landing near Birmingham, Ala. The plane had just taken off for Washington from Roberts Field.

Fog and a stalling motor caused this fatal crash at Belair, Md. The pilot, Jack Albright, was "flying blind" for a landing when the plane hit a tree. He was killed.

Flying low over St. Maur les Fossés, France, André Laborie's plane hit a tree, bounded off, and landed on a roof. He was only scratched.

When all three motors of a Ford monoplane (above) failed over Cleveland, O., Pilot Taylor landed it in a small lot, uprooting a tree, but saving his 12 passengers.

What an eighty-four-mile gale did to a $175,000 Army bombing plane at Buffalo, N. Y. In the wind's grip, the huge ship was damaged beyond repair.

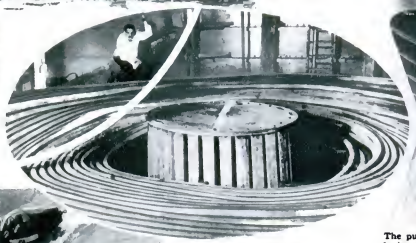
Caught in the ice. After a perfect landing on the frozen surface of Lake Ashuapmouchouan, in northern Quebec, this monoplane, piloted by Capt. K. F. Saunders, broke through and was imprisoned for eight days.

From a height of 2,000 feet, a plane flown by Andrew Allensworth and Chester Decker fell squarely on an auto parked in a Detroit street. Two persons, preparing to enter the car, saw the airplane coming and fled.

Laying the New Baltic Cable

Link Between Finland and Sweden Will Carry Nine Messages at Once

The cable ship *Horderney*, which laid the world's newest cable, 130 miles long, connecting Norteije, Sweden, and Abo, Finland.



The heavy undersea cable being paid out from a huge coil in the hold of the vessel. In some places it was laid to a depth of several hundred feet in the Baltic Sea.

The pulley mechanism at the stern of the cable laying ship, over which the cable is seen passing overboard into the sea. A similar device at the bow of the vessel picks up cable when necessary.

A small boat of the *Horderney* towing in one of the buoys which were anchored at intervals to mark the course of the cable.

Launching one of the huge marking buoys from the deck of the cable ship. The cable had to be threaded through the many islands of the Aland Archipelago, at the mouth of the Gulf of Bothnia.

Preparing to launch a number of small balloon buoys which were used to float the end of the cable to shore. The completed cable can handle nine messages at once.

The Last Word in Toys

The movie comedian, Harold Lloyd, built this miniature Old English house for his daughter Gloria. A perfect little stable near by houses the child's pony and cart.

The latest word in hoop-rolling. Six-year-old Mario Conterio of Paris, France, all set to tear along on his motor-driven unicycle.

Three-year-old Werner Kimpel, son of a famous German auto racer, prepares to test the speed of his own electric racing model.

Thomasina Mix, daughter of Tom Mix, famous horseman of the movies, shows a playmate the real Western saddle, hobbyhorse size but with all the fancy trimmings, that her daddy has given her.

R. E. Hurst spent 12 years building for his children this perfect model of an old castle on his estate at Boxhill, England.

Alfredo Bonigatti, four, drives this tiny motorcycle through the streets of Rome

Will Rogers, famous humorist, rigged up this wooden horse in a practice cage on his California ranch to help his daughter Mary improve her skill in playing polo.

QUEER BEAKS *for* Queer Birds

The strong, sharp-pointed beak of this Guinea fowl, a native of Africa, serves as a pickax to tear up the ground in search of roots, bulbs, and insects. Its queer, bare-faced head is encased in a bony helmet, like a knight in armor. This species wears a crest.

A rare bird is the combed duck—and one of the nosiest. It wears its comb on the top of its beak instead of on top of its head, for no apparent purpose except to be different.

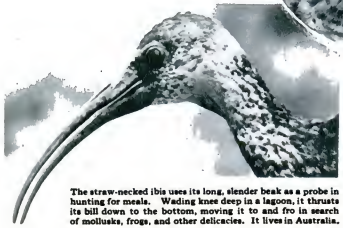
With an enormous scooplike bill at the end of an extremely long neck, the Indian flamingo is mechanically equipped for dredging in the mud bottoms of ponds and marshes for small crabs, snails, and vegetable matter. The beak, bent to scoop backward, is like a deep, pointed box fitted with a small lid. The bird is a noisy eater.

Who wouldn't grin with a crowbar beak like this? Grub hunting comes easy for the Jebiru stork of tropical America, for it can plow the ground with a thrust of its sharp, turned-up bill. It is nearly five feet tall.

Since the pelican dines on fish and is an enormous eater, Nature has equipped it with a fish basket attached beneath its bill. In this pouch it carries home food for its young. This species is the white pelican of North America. On the bird's upper mandible can be seen a curious growth, the purpose of which is unknown.

Shy and handsome, the plumed peacock has just enough beak to tackle small lizards and frogs. It prefers grains, grasses, and buds.

The crested hawk eagle, with its powerful hooked beak, is a terror to poultry and small animals. It dines on monkeys, rats, rabbits, birds as large as geese, and even lambs and goats. Its native haunts are in the forests of Central and South America.



The straw-necked ibis uses its long, slender beak as a probe in hunting for meals. Wading knee deep in a lagoon, it thrusts its bill down to the bottom, moving it to and fro in search of mollusks, frogs, and other delicacies. It lives in Australia.

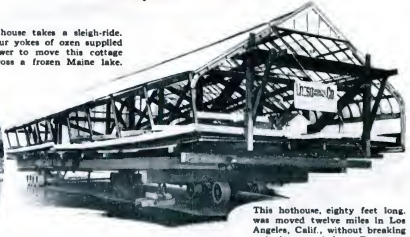
The grotesque bill of the toucan is almost as long as the bird itself, and almost equal in bulk to rest of the body. Luckily its thin walls make it light enough to manage.

Never Too Big *to* Move

Eight miles of railroad track were used in moving this seven-story building 100 feet to make room for a boulevard in Chicago. Not a window was cracked.

Moving Our Lady of Lourdes church in Chicago to a new site across the street was a task presenting unusual difficulties. The new location is seen in foreground of picture above.

A house takes a sleigh-ride. Four yokes of oxen supplied power to move this cottage across a frozen Maine lake.



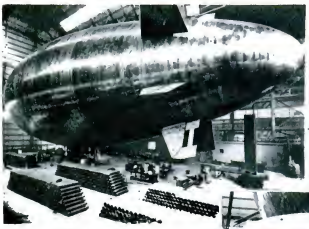
This hothouse, eighty feet long, was moved twelve miles in Los Angeles, Calif., without breaking a single pane of glass. The photo shows it supported on cribbing.

Loaded on barges, twelve modern houses were shipped across the Kanawha River at Charleston, W. Va., to new foundations. Here is one of them on the way (left).

A twenty-three-room residence in Los Angeles cut in half and moved in sections. With guests at the windows, enjoying the ride, each half was hauled a mile by motor trucks—at night.

Street traffic was halted and overhead wires were torn down to clear the way for the journey of this thirty-three-room house along the thoroughfares of Brooklyn, N. Y. After a trip of about half a mile, the dwelling, seen making a turn, arrived at its new location little the worse for its travels.

Keeping Pace with Aviation



First All-Metal Blimp

With gas envelope, as well as framework, made of lightweight duralumin, the Navy's new 200,000 cubic-foot blimp *ZMC-2* marks the latest advance from the war-time "rubber cow." It was completed recently in Detroit for experimental purposes. Above is the new ship in its hangar, and at the right on a test flight. Twin 200-horsepower motors drive it seventy miles an hour.

Interior view of the cabin of the new all-metal blimp, showing gasoline tanks behind the pilots' seats. The tanks hold enough fuel for a 1,300-mile cruise.

An Automatic Pilot. Lieut. A. Willett (left) of Crissy Field, Calif., demonstrates a new flying robot he has invented to take control of a plane if anything happens to the pilot. It is said to prevent tail spins.

A Hornet's Nest

A remarkable sky photograph of the U. S. aircraft carrier *Saratoga* carrying a flock of eighty fighting planes lined up on its landing-field deck. The plane flying ahead of the vessel has just taken off after a short run on deck.

Sky Promenade

So large is the Navy's PN-12 patrol plane that the top of its great fishlike body serves as a promenade deck for members of the crew. Here the pilot or mechanic can stretch his legs by taking a stroll between the forward and rear cockpits, as in the photograph at the left. This improved type of Navy flying boat is driven by twin air-cooled motors. In the nose are twin cockpits, side by side.

Rockets to "Boost" Heavy Planes — Flying Boat Sheds Its Wings — Air Records and Inventions

CARTRIDGES that start airplane motors, and rockets that boost a heavy plane into the air, are two innovations in aviation.

Rockets were tried out recently to give a heavy seaplane a flying start in a test near Dessau on the Elbe River, Germany. A standard Junkers monoplane used in the experiment was equipped with six rockets under the wings and towed to the center of the river, its engine throttled down. When all was ready the pilot fired the rockets one by one, by electricity. At each successive explosion the plane leaped forward like a projectile, until at the last blast it reached sufficient speed to clear the water and continue in the air under normal power. Eventually it is hoped to use rockets to boost planes carrying 2,500 pounds of load into the air.

A self-starter for airplanes that uses an exploding cartridge to crank the motor is the subject of experiments by engineers of a Garden City, N. Y., airplane firm. The whole starting device weighs only two pounds. It consists of a steel tube or explosion barrel, to the breech of which is fastened an explosive cartridge half the size of a shotgun shell. Pulling a trigger fires the cartridge, and the explosion force transmitted into one of the cylinders starts the motor.

"Fly It Yourself"

NOW anyone who cannot afford a plane may hire one and fly it himself—provided he has a pilot's license. A hundred planes are made available to would-be pilots by the first "fly-it-yourself" company, recently established at Kansas City, Mo.

The procedure is similar to that of auto-renting concerns; produce a license, obtain a plane, and fly it away. Although the rate for the use of the planes had not been decided definitely at this writing, it was expected to be between fifteen and twenty dollars an hour.

Turbine Motors Next?

TURBINE motors for airplanes are seen as a possible development in aviation engineering, in a recent symposium of opinions of leading designers.

"The turbine principle is the ultimate toward which we may strive," declares Charles L. Lawrance, designer of the Wright Whirlwind motors that carried Lindbergh and many of his transatlantic successors to fame. "Whether it can be converted for airplane use is a matter of long research, but it is the most attractive of all engineering principles."

Despite its recent successes in experiments, the Diesel type of engine, which burns heavy oil instead of gasoline, may never succeed for airplane use, in the opinion of F. B. Rentschler, builder of the Pratt and Whitney motors used for transport and military aircraft. Its weight per horsepower, he says, is likely to remain greater than that of a gasoline engine. Another disadvantage is the thickening of its low-grade though economical fuel in cold weather.

Henry Ford, builder of automobiles and airplanes, champions the Diesel type. He also predicts that fuels made from farm wastes will replace petroleum products when the country's oil supply runs low.

First Airplane Post Office

A fleet of new eighteen-passenger Boeing transport planes for San Francisco-Chicago service have cabins quickly convertible into aerial post offices. The cabins, which are nineteen feet long and five and one-half feet wide, allow ample room for sorting the mail.

Refueling Across U. S.

REFUELING a plane in the air, a recently developed art, made possible the first nonstop flight across the continent from coast to coast and back again. In a leisurely five-day flight, Lieut. N. B. Mamer and A. Walker covered the 7,200-mile distance from Seattle to New York and back again without alighting. Over cities along the route they made frequent contacts with refueling planes, from which they obtained gasoline by hose.

The flight was made over established mail routes, and was watched with interest by officials considering the use of refueling planes to speed up the air mail. Following its successful conclusion, Capt. Ira Eaker, who was a member of the Army endurance plane *Question Mark* that made a duration record last January, undertook a similar cross-country refueling flight, with Lieut. B. Thompson as co-pilot. On this flight mail was dropped when gasoline was taken aboard.

Inventions for Airships

A SECTIONAL airship made up of individual units that will fly by themselves is the novel machine patented by James N. Lewis, New York City inventor. Each section would be provided with its own motive power and steering apparatus for separate use, but when combined they would form one great flying craft with a single control and a small crew.

Seven years since application was made, the United States Patent Office has just granted a patent to Dr. Hugo Eckener, commander of the round-the-world airship *Graf Zeppelin*, on an arrangement of gas cells embodied in its construction. This arrangement is understood to provide a way, by means of a collapsible inner cell, for lifting gas to occupy space vacated by consumed fuel gas without allowing the two to mix.

Helium Prices Drop

THE latest chapter in the story of the United States Government's efforts to obtain a sufficient and cheap supply of helium, the noninflammable gas for its great airships, is found in the recent announcement that a new Government helium extraction plant at Soncy, near Amarillo, Texas, which made its first shipment of the gas last May, is now producing it at the record low cost of two cents a cubic foot.

Before the World War, helium was a curiosity of scientific laboratories and cost $2,000 a cubic foot. Research by experts of the United States Bureau of Mines brought the cost down to the present figure. Recently new helium sources of unusual richness have been discovered in Colorado and Utah, and when they are exploited the cost may decrease still farther.

Glider Towed 160 Miles

AERIAL trains, composed of planes towing gliders, were recently brought nearer realization with what is said to be the longest flight ever made in a motorless plane pulled by a power machine. The pilot of the glider, Hugh C. Robbins, of Akron, O., was towed 160 miles from Ypsilanti, Mich., to Akron by an airplane speeding at sixty miles an hour. A 300-foot cable connected the glider with the plane in flight, and Robbins cast the rope loose from his "engine" to land

after the trip of nearly three hours.

Although other experiments in towing gliders with airplanes had been made previously in the United States and in Germany, where the idea originated, this is believed to be the most extensive test to date of the novel scheme.

A 10,000-Foot Tumble

WHAT is believed to be a world's record for a long drop with an unopened parachute was established recently over Chicago. Jack Cope, veteran pilot and stunt flyer, of Chicago, leaped from a plane flying 15,000 feet over the municipal airport and waited until he had fallen a distance estimated at 10,000 feet before he pulled the cord that opened his parachute. A short time before, Rex Harker, of East Liverpool, O., had fallen freely for 9,600 feet in performing a similar feat at Cincinnati, O.

In theory, at least, it is now known that there is no limit to the distance a jumper can safely fall. Army Air Corps experiments show that, contrary to previously accepted notions, a falling man quickly reaches a maximum velocity. Friction of the air then prevents him from falling faster than about 120 miles an hour, irrespective of the length of his drop.

Worse Than Falling

FALLING through the air may seem to most laymen the most thrilling sensation imaginable. Actually a much queerer feeling is that of sitting in a plane launched by a catapult, according to those who have tried it.

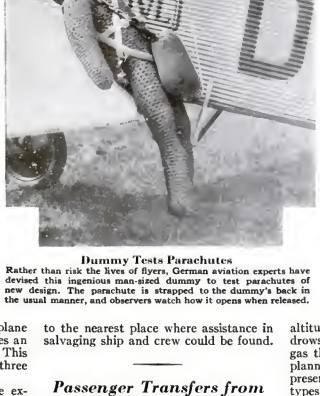
Everyone is familiar with the way occupants of an automobile are thrown back against their seats when an inexperienced driver lets in the clutch with a jerk. Imagine that sensation prolonged for an appreciable length of time, and it will give a fair idea of the sensations of a pilot while a Navy catapult is boosting a plane from rest to a velocity of sixty miles an hour in a second and a half. This acceleration is between two and three times that of a falling object.

Although not uncomfortable, the experience of catapult launching is unique, and never to be forgotten, according to Lieut. W. M. Sellers, U. S. N. "The cessation of horizontal acceleration at the end of the run," he says, "produces almost as pronounced a sensation as the original one."

On the other hand, the sensation of falling may be nothing but an optical illusion, new tests indicate. Eight Army men under the direction of Lieuts. R. J. Smith and F. K. Sauer recently leaped with parachutes from planes over San Antonio, Texas. None had ever made a parachute jump before. According to their instructions, they avoided looking at ground or plane. At the conclusion of the experiment, all of them said that they felt no sensation of falling.

Discards Wings at Sea

AMONG current novelties in airplane design is a transatlantic plane that will drop its wings if forced to alight at sea, then ride the waves like a boat. This machine, as worked out by engineers of the great Bleriot aircraft plant in France, would be a veritable ocean liner with wings, equipped with both air and marine propellers. Should storms or mishap force it down, the crew could detach the wings and throw them overboard. Then, after communicating by radio with ship or shore, they would drive the craft under its own power, like a giant motor boat, to the nearest place where assistance in salvaging ship and crew could be found.



Dummy Tests Parachutes

Rather than risk the lives of flyers, German aviation experts have devised this ingenious man-sized dummy to test parachutes of new design. The parachute is strapped to the dummy's back in the usual manner, and observers watch how it opens when released.

Passenger Transfers from Dirigible to Plane

A NAVAL officer swung through a trap-door in the keel of the great dirigible *Los Angeles*, over Cleveland, the other day. He risked a four-foot jump, in the blast of a forty-five-mile wind, to the wing of a plane that hung from a trapeze beneath him. A few seconds later the fast plane cut itself loose and landed him on the ground. Thus was accomplished what is said to be the first transfer of a man from a flying dirigible to a plane.

This stunt, which thrilled the crowds that witnessed the Cleveland, O., air races held recently, was an unscheduled part of a demonstration of a dirigible's ability to pick up and dispatch planes in flight. In the test a fast Navy plane had come up from behind the *Los Angeles*, maneuvered beneath it, and had been hooked to a seventeen-foot trapeze, a semirigid sort of cradle hanging from the larger craft. To transfer the passenger, Lieut. C. M. Bolster, to its forward cockpit, the trapeze was then pulled up until the plane was close enough to risk leaping the intervening distance. In the demonstration a heavy plane was also successfully picked up and released by the dirigible, but no passengers transferred.

The maneuver has been performed only a few times before, in secret Navy tests. High officials are interested in the scheme since it would allow the dirigible to "mother" fast observation planes in wartime. Also, for commercial use, it would enable passengers to be put aboard dirigible air liners in the air. The Navy's two new dirigibles, under construction, are especially designed to carry airplanes as regular equipment, to be launched and picked up in flight.

3,500 New Planes

THIRTY-FIVE hundred new commercial and military planes took the air during the first six months of this year. This was the combined production of the country's airplane factories for that period, according to the Aeronautical Chamber of Commerce of America. The number of commercial airplanes manufactured was eighty percent of the entire production of 1928.

A High Flyer's Helmet

A HELMET such as a diver wears may enable a pilot to fly ten miles above the earth, according to Lieut. Apollo Soucek, Navy flyer and holder of the world altitude record for seaplanes. Such a helmet would keep the pilot's head in atmosphere similar in pressure to that at sea level.

On his recent record flight to an altitude of 38,560 feet, says Soucek, he felt drowsy, although breathing pure oxygen gas through a tube. At this writing he planned another attempt to eclipse the present world's altitude record for all types of planes of 42,123 feet set last May by Willy Neunhofer, German pilot.

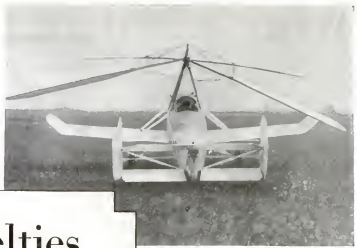
States Agree on Air Laws

FORTY-ONE states, each with its own code of laws governing aircraft, have arrived independently at a remarkable agreement in air rules, according to a recent survey by the Aeronautical Chamber of Commerce of America.

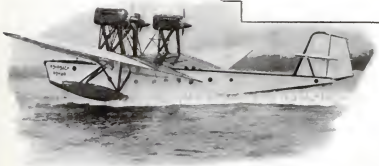
Although chaotic conditions were feared as a result of the states' individual power to enact aviation laws, the survey showed a surprising uniformity among them. Of the states which have made air rules, Florida has been the most active, considering twenty-nine bills and enacting eleven during 1928 and 1929.

Novelties In Aircraft Science

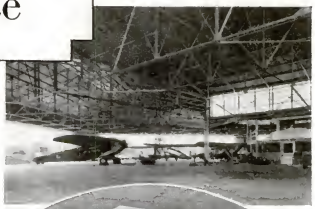
Latest model of the autogiro "windmill plane" invented by Juan de la Cierva. In a recent test flight at Pitcairn Field, near Philadelphia, it descended almost vertically and landed in one spot without any rolling.

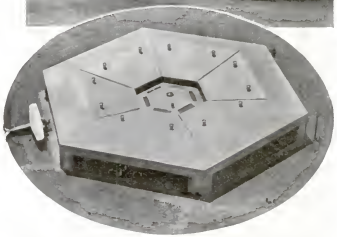


The tail of the new autogiro, showing its biplane horizontal stabilizer and elevator, and double vertical stabilizers and rudders. The elevator is tilted to deflect the wind stream up to the vanes to start the plane.



The *Romar*, an enormous new Rohrbach flying boat, built in Germany as one unit of a projected fleet of air liners for transatlantic passenger service. Powered by three motors, it is said to develop a speed of more than 130 miles an hour. This photo shows the great ship skimming the waters of the Baltic at the start of a test flight.





This novel hexagonal hangar, said to be the largest airplane shed in America, houses planes of the Western Air Express at Los Angeles. With six doorways, each 120 feet wide, it can service six huge transport planes at once. Upper view shows the interior of the hangar.

Part of the regular equipment of the new German steamship *Bremen* is this ingenious catapult for launching ship-to-shore planes from the deck. Mounted on a turntable, it permits a take-off in any direction. The plane, projected from a starting carriage by compressed air, attains flying speed within 66 feet, and speeds 68 miles an hour three feet after leaving the catapult.

Something new in ship-to-shore service—the Goodyear blimp *Volunteer* transferring a passenger from the steamship *City of Honolulu* near Los Angeles. After the passenger had left the liner in a small boat, the blimp was lowered almost to the water and, coming alongside, took the passenger aboard.

Who "Planted" the Glozel Fakes?

Emil Fradin (left), young French peasant who dug up the "prehistoric relics" at Glozel, and Dr. Morlet, who first called the discovery to the attention of scientists.

Scientific Sleuths Find That "Caveman Relics" Dug by French Farm Boy Are a Gigantic Hoax, Halting Bitter Dispute

By MICHEL MOK

A PIECE of clay crumbled in a man's hand during a simple test in a Paris laboratory a few weeks ago. With it crumbled the last prop under an elaborate structure of theories concerning the birthplace of civilization that had divided European scientists into bitterly warring factions for more than five years.

The bit of clay was a small tablet, covered with crude hieroglyphics, taken from a strange assortment of thousands of knickknacks, including stone weapons, bone implements, vases, vessels, and ornaments, that were dug up by a farm boy at Glozel, a little village near Vichy, France, in 1924, and afterward pronounced priceless prehistoric relics by several leading archeologists.

The "find," these enthusiastic authorities told the world, indicated the existence of a highly developed Stone Age civilization in Western Europe about 12,000 years ago. The "ancient" objects, they said, proved that, in that dim era, there lived in what now are France, Spain, and Portugal a species of cultured cave man who, instead of wooing his beloved with a club, carved love letters in clay thousands of years before the Phoenicians had invented the ABC's, and drank her health out of glass goblets many centuries before the Egyptians had made their impressive entrance upon the scene of antiquity.

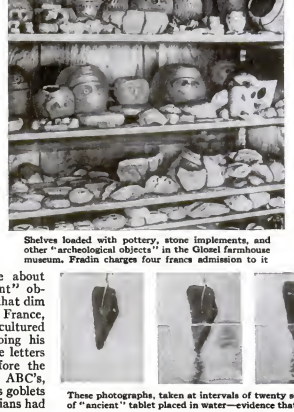
This announcement aroused tremendous interest. But its sponsors did not stop there. They propounded a set of new theories about the early development of mankind. The excavations, they said, showed that all prehistory had to be rewritten; that civilization, instead of having started in Asia and moved westward, had begun in southern Europe and swept toward the east; that the great libraries of the world were cluttered with rubbish and that the universities were teaching a lot of nonsense.

These contentions aroused a storm of controversy. All scientific Gaul was divided into Glozelians and anti-Glozelians. The antis branded the Glozelian ideas with the French equivalent for "bunk." The pros retaliated, calling the antis cowards who were afraid of the overthrow of their pet theories. More than once, staid lecture and meeting halls became the scenes of fist fights between adherents of the hostile camps. Feeling finally waxed so bitter that all French scientific societies forbade the use of the word "Glozel" at their sessions. Meanwhile, the controversy had spread to several other European countries until it assumed the proportions of a scientific world war.

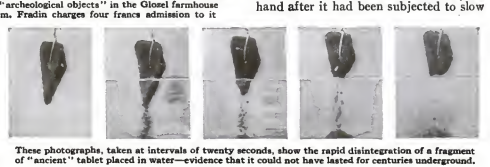
A CLIMAX came when a congress of the International Institute of Anthropology at Amsterdam, Holland was almost disrupted by an acrimonious debate on the subject. A commission of inquiry, comprising eight experts from various countries, was appointed to determine the authenticity of the "relics." This international jury, unique in the annals of science, found, in effect, that the whole affair was a colossal fake.

Peace? Far from it. "Fraud! Bias! Packed jury!" cried the Glozelians. Law suits for libel and defamation of character followed. Then one of the judges had an inspiration. He ordered some of the prehistoric gewgaws taken from the farm at Glozel to be examined by M. Edmond Bayle, director of the laboratory of legal identification. In a police raid, ten pieces were selected at random.

Now, M. Bayle does not profess to be an archeologist or an anthropologist, but he does know his chemistry and microscopy. He made a careful analysis of a couple of the inscribed clay tablets which, because they were presumed to prove that the Europeans of 10,000 B.C. mastered the art of writing, had been among the chief causes of the rumpus. The condition of the microörganisms in the clay of one of the pieces, he reported the other day, showed that it never could have been baked. Consequently, it could not have survived long in the ground. The other tablet crumbled in M. Bayle's hand after it had been subjected to slow



Shelves loaded with pottery, stone implements, and other "archeological objects" in the Glozel farmhouse museum. Fradin charges four francs admission to it



These photographs, taken at intervals of twenty seconds, show the rapid disintegration of a fragment of "ancient" tablet placed in water—evidence that it could not have lasted for centuries underground.

The work of a joker? One of the Glozel rocks with "caveman" etching of a reindeer, genuine pictures of which have been found carved on the walls of caves in France.

trated seems definitely exposed. The Phoenicians have been restored to their high historic perch as the originators of the alphabet and they, the Egyptians, and the Greeks, to their niches as the fathers of early Western civilization.

Still the Glozelians, whose archeological reputations appear very much the worse for wear, have one more chance to redeem themselves. It has been suggested that the leaders on both sides select their own specimens for a public chemical and microscopic analysis. Up to the time of this writing, nobody has taken advantage of this opportunity.

infiltration of water, such as would have taken place on a much larger scale during years in the soil.

The scientific sleuth picked a tiny bit of grass out of a piece of earthenware, put it under the microscope, and found that all of its cells had remained intact. This, of course, could not have happened had it been underground for centuries. In other pieces of pottery he discovered fragments of thread that had been colored with aniline dyes, which were not invented until the twentieth century. And some of the "ancient" bone instruments were still filled with marrow!

THE investigator concluded that none of the trinkets could be more than five or six years old. Since they were first unearthed, their "antiquity" has diminished with breath-taking rapidity. The early enthusiasts recognized them as the remains of a civilization dating back at least 10,000 years. Then a dissenting expert pronounced them to be the paraphernalia of a sorcerer of the time of the Roman occupation of Gaul. That brought them down to about three centuries after Christ. The international committee thought they had been "planted" by a joker in mid-Victorian days. Now, according to M. Bayle, they are not even "prewar."

Thus, what probably will go down in history as the greatest scientific hoax ever perpe-

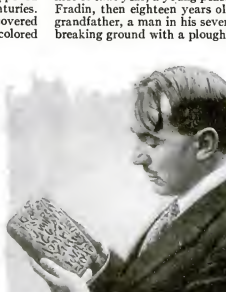
The first act of this strange scientific comedy of errors was played in the early part of 1924. In the morning of March first of that year, a young peasant, Emile Fradin, then eighteen years old, and his grandfather, a man in his seventies, were breaking ground with a plough drawn by two bullocks, the lad urging on the animals, and the old man directing the plough. The field, which had been used as a pasture, had never been ploughed before.

SUDDENLY, Grandfather Fradin had the handles torn from his hands by the plough striking something that would not give. Emile took a spade to locate the trouble. Instead of finding rock, he disclosed a trough, about the length of a man's body, made of stone and bricks which, when exposed to the sun, glittered as if they had been glazed. Inside was the collection of "archeological objects." There were clay pots, carved pebbles, stone rings, bone and flint fishhooks and needles, stray pieces of what seemed human bone, odd clay facial images or masks with round eyes but without mouths and—clay tablets covered with alphabet signs.

The Fradins at once presumed that the stuff they turned up must be very ancient and called in the local school teacher. This worthy assisted Emile in labeling most of the objects, which were placed in a room next to the kitchen in the humble Fradin farmhouse. This is the famous "Glozel Museum," and young Emile to this day charges four francs admission to see his knickknacks.

In the region around Vichy archeological deposits from Gallo-Roman times are no rarity, and so the Fradin collection attracted little attention for about a year.

But then the fun started. One day a Dr. Morlet, a liver specialist from Vichy, noted for its mineral springs, visited the Fradin museum. Dr. Morlet had become interested in archeology several years before, when he found a Roman statuette buried in his garden, and was impressed by Emile's array of curios. He was particularly struck by the clay pots and human images, which he recognized as resembling objects from the Paleolithic era, or Stone Age, the earliest known period of human culture. But one thing puzzled him greatly. These "relics" were marked with signs similar to the letters of the Phoenician alphabet, which was not originated until thousands of years later.



Dr. Morlet examining one of the curiously inscribed stone tablets unearthed at Glozel. More than a hundred different characters, like those at the right, were found. Who was the perpetrator of this scientific hoax?

When the doctor saw, however, that the clay tablets were inscribed with the same kind of hieroglyphics, he realized that he was confronted by an archeological problem beyond his powers of solution. So he called in some professional archeologists. They, too, had to admit that they could make nothing of it.

BY THIS time the news of the sensational discovery had spread in scientific circles and some of the leading experts began to appear on the scene. Among these were Dr. Salomon Reinach, curator of the Prehistoric Museum at Saint Germain-en-Laye; Dr. Camille Jullian, noted historian and Gallo-Roman specialist who is also connected with the Saint Germain Museum; Professor Loth, of the Sorbonne, (Continued on page 158)

Investigating committee of noted archeologists on the site of the Glozel discovery. Miss Garrod stands at the center. "Fraud" was their verdict, given unanimously.

Poison Gas for War on Rats

EACH year the damage caused by rats costs the American people more than $200,000,000. A single pair of rats yields 15,000,000 offspring in six years, though not all survive. These carriers of plague far outnumber the world's population, and have caused more deaths than all the wars in history.

By

GEORGE LEE DOWD, JR.

DEADLY poison gas that wiped out battalions of men during the World War is the latest weapon employed by the United States Public Health Service in its war on disease-carrying rats. Mixed with a warning "tear gas," the same hydrocyanic acid which, bursting from shells over the trenches, brought paralysis and death to thousands of soldiers, is now being pumped into the holds of ships arriving from foreign countries to rid them of the pests that menace life and property. Under the latest quarantine regulations, all vessels engaged in foreign trade must be "gassed" at least once every six months.

There is ample cause for such drastic measures. Dr. E. W. Nelson, formerly chief of the United States Biological Survey, said not long ago that rats are more dangerous to humanity than lions, tigers, wolves, snakes, or man-eating sharks, and have been responsible for more untimely deaths than all the wars of history. Another authority declared that the destruction of property wrought by the hordes of rats that overrun the world is much greater than that caused by all other noxious animals combined.

COLD statistics bear out the truth of these statements. In the 2,000 years of the Christian era, 2,000,000,000 persons—more than the entire present population of the earth—have died from bubonic plague, the germs of which, the British Plague Commission discovered twenty years ago, are carried by fleas that infest the fur of rats. At times this horrible ancient disease has almost annihilated entire races. In the fourteenth century, most of Europe was devastated by the "black plague," as it was then called, the toll amounting to 25,000,000 persons. In A.D., 534 it carried off 10,000 persons in Constantinople in one day. It claimed 70,000 victims in London in 1665, the year of the Great Plague. And as recently as 1896, it was responsible for 9,000,000 deaths in India.

The modern physician is as powerless against the plague as was the barber-surgeon of medieval times, but science today knows how to avert its spread. Following outbreaks of the disease in San Francisco, Seattle, and Hawaii in 1909, in Porto Rico in 1912, and in New Orleans in 1914, epidemics were prevented by prompt and vigorous action by the United States Public Health Service.

Experiments with rats in the laboratory aid medical science in combating human diseases.

A gas attack on rats. The poisonous fumes, generated in the tank shown above, are driven through a flexible tube into the rat hole.

Medical science is beginning to blame the rat for several other dangerous diseases. Its complicity in spreading typhus is virtually established and the animal is suspected of carrying measles and foot-and-mouth disease. In addition, it has been accused, but not convicted, of causing cancer, infantile paralysis, and trichinosis, an intestinal disorder resulting from eating infected meat. The latest charge against the rat, resulting from a survey by London health officers, is that of inflicting rheumatism upon human beings.

But the rat is not only an arch murderer; it is also the most cunning thief in the animal kingdom. According to the Public Health Service, there is one rat for every man, woman and child in the United States and each one does a half cent's worth of damage a day. Roughly, therefore, rats cost the American people more than $200,000,000 a year.

In Great Britain, the economic havoc wrought by the rodents is even greater, a recent estimate placing the damage at a billion dollars annually. Experts have calculated that the money loss suffered by the entire world as a result of the rats' depredations amounts to some five billion dollars each year.

Investigators estimate that there are at least six billion of the creatures on earth. With the possible exception of the polar regions, no place is free from them. Wherever man goes, the rat accompanies him, traveling from continent to continent in ships and from city to city on freight trains. Recently, the first "air-minded" rat was found in the cabin of a European passenger airplane.

In the United States, rats are believed to be slightly on the decrease as a result of the war waged upon them by the Public Health Service and the campaign of education carried on by the United States Biological Survey. Not only are foreign vessels "gassed," but each rope and cable connecting a ship with a pier is protected with huge tin rat guards to bar the animals from shore. As a result of the Government's educational campaign, farmers and warehouse owners have learned how to make their barns and other buildings rat-proof.

One of the tin rat guards which are attached to docking cables of vessels to prevent the rats from reaching shore.

THE chief difficulty in rat-control is the rapidity with which the creatures multiply when a sufficient food supply is available. A pair of healthy rats breeds about six times a year, producing from six to ten rats, which in turn begin to multiply when three months old. According to Professor G. G. Chambers, of the University of Pennsylvania, the progeny of a single pair would total about 15,000,000 in six years.

Thus, in times of plenty, their spread reaches tremendous proportions and organized rat-killing campaigns must be conducted. In one such crusade in Texas last year, more than 2,000,000 rats, enough to fill (*Continued on page 104*)

Science Builds Fortress Vaults to Outwit Safe Crackers

By
HENRY MORTON ROBINSON

IN WALL Street, New York City, a skyscraper sixty stories high is rising. At the heart of this great edifice a trust company is building a mammoth vault, an armored fortress of steel and concrete. Cunningly it is laced with electric wires, and clarion gongs will broadcast the slightest tampering with any part of the vault.

Behind its doors may lie upward of $1,000,000,000 on deposit. Every human and mechanical device will be employed to guard that treasure from the vault wrecker. Officials of the bank will stake their reputations, and the depositors will stake their wealth on the security offered by the new vault. For they firmly believe that the golden harvest piled behind the 100-ton door will be safe.

But *will* it be?

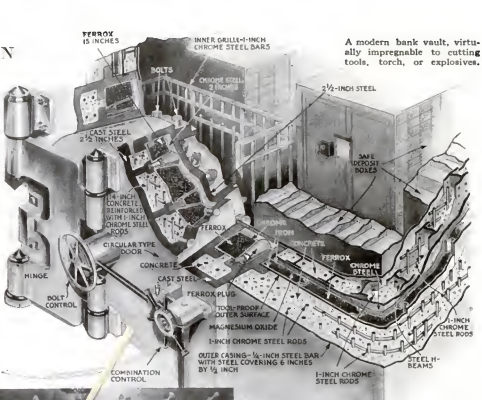
I put that question to a distinguished vault engineer, who has built some of the strongest vaults in existence. His answer amazed me.

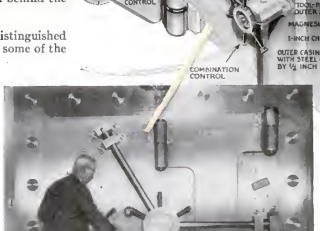
"Give me a million dollars with which to build a vault," he said, "and there would still be half a dozen men in the world who could open and rob it!"

Nor are these men Houdinis, or Jimmy Valentines who open tumbler locks with sandpapered fingers. They are experts in the use of two of the most terrible safe-breaking weapons known to science—the "fluxing rod" and the "oxygen lance." Against these latest potential tools of safe breakers, no absolute defense is known. The financial world is waiting to see what super-criminal may be the first to use them, for to date none has dared employ either. The threat of these weapons, despite the practical difficulties that attend their use by safe crackers, is more thrilling than any Jimmy Valentine romance; the latter is an impossible fiction, but the former is a remote but real danger.

The never-ending battle between the safe makers and the safe breakers is a game of matching wits, with odds shifting from one side to the other, in which nothing is "impossible," as the evolution of modern burglar-proofing of vaults testifies.

Only a few people remember Jimmy Hope, but about fifty years ago his name would strike bank presidents with terror. About 1880 he distinguished himself by boring through the floor of the Ocean National Bank of New York and removing $1,550,000 in gold and negotiable bonds from its "burglar-proof" vaults. A few years later, the Manhattan Institute for Savings proudly announced a genuinely burglar-proof vault, whose four-foot wall was studded with cannon balls and whose two-ton door swung on massive hinges and locked with six enormous bolts sunk deep into the vault's framework. Jimmy Hope and his expert henchmen entered the bank one day, pried open the two-ton door with giant wedges, walked in, and departed with $2,750,000 in cash and negotiable securities. To save the bank from ruin Congress had to pass a special act cancelling the stolen numbered bonds, and even then the bank suffered a million-dollar loss or more.





Unlocking the massive circular door to the vault of the Central Savings Bank, New York. The center wheel controls the bolts.

THEN came the invention of the step-door, which was thought to be the answer to wedges. Its edge, composed of a series of right-angled steps, did not permit the entry of an ordinary wedge for more than half an inch. For a while it looked as if science was ahead of the cracksman. But flexible wedges in the hands of master cracksmen showed that even these doors were not always burglar-proof. They were followed by doors edged with complicated patterns of tongues and grooves, making entry of a wedge virtually impossible.

The cracksman had a new trick up his sleeve. He forced nitroglycerine into the cracks of the doors. Where the tongues and grooves were a perfect defense against wedges, they were an easy prey to the explosive. "When I first saw a safe that had been wrecked with nitroglycerine," one engineer says, "I could not believe that solid metal could be so twisted and torn."

But science had two more weapons. One was to eliminate the tongues and grooves and to revert to the cone-shaped "plug" door, now more carefully machined to fit closer than ever before. The cone shape meant that a charge of explosive would shoot harmlessly out through the

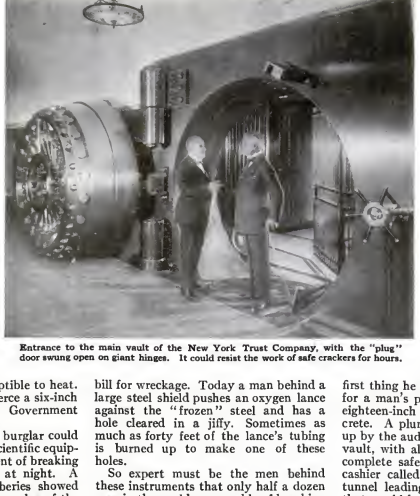
crack without twisting the door from its hinges. The other was to adopt the use of armor plate similar to that used in battleships. Soon explosion-proof vaults were a reality. Science was ahead in the battle with the crooks.

THEN the struggle entered its modern stage with the invention of the acetylene torch. Devised by a German and applied for legitimate industrial use in cutting away twisted steel girders in buildings demolished by fire, this formidable instrument shears its way through steel like a knife through macaroni. It develops a temperature of 5,000 degrees F., hot enough to cut massive armor-plate slabs like so much mosquito netting. Although armor plate is very tough, it is also susceptible to heat. An acetylene torch can pierce a six-inch plate in ten minutes, as Government tests have shown.

It was not long before a burglar could avail himself of the latest scientific equipment by the simple expedient of breaking through a garage window at night. A series of minor bank robberies showed that yeggs fully realized the value of the oxy-acetylene torch in their trade. They were literally burning up small country vaults with their new tool.

Today science meets the threat of the "cutter-burner," as it is familiarly known to vault men, with composite walls that embody materials resistant to heat, drills, and explosives. Such walls, however, cannot meet the new threat of the "fluxing rod" and the "oxygen lance." A torch and a "fluxing rod" can cut through any known combination of elements. Solid granite a foot thick can be pierced in ten minutes. It crumbles under the rapid heating. Armor plate burns up in half that time. This magic rod is simply a stick of soft steel which the expert operator holds against the metal to be burned. Then he applies the oxy-acetylene flame to the tip of the fluxing rod, which oxidizes so rapidly that the temperature can be raised to unbelievable heights. No burglar has used the fluxing rod yet.

THE "oxygen lance" has been known for fifteen or twenty years to a few blast furnace experts. It consists of a long, small iron pipe about a quarter of an inch in diameter, through which oxygen gas is forced under pressure. The business end of the pipe is heated red-hot by a cutter-burner. The hot iron ignites in the oxygen stream and flares fiercely. Held against any object, it burns its way straight through. Nothing will stop it. Blast furnace men use the oxygen lance to free "frozen" tap-holes in blast furnaces. Formerly when a tap-hole became clogged with steel there was nothing to do but dynamite the furnace and pay a $10,000 bill for wreckage. Today a man behind a large steel shield pushes an oxygen lance against the "frozen" steel and has a hole cleared in a jiffy. Sometimes as much as forty feet of the lance's tubing is burned up to make one of these holes.



Entrance to the main vault of the New York Trust Company, with the "plug" door swung open on giant hinges. It could resist the work of safe crackers for hours.

So expert must be the men behind these instruments that only half a dozen men in the world are capable of breaking into a vault with them. Fortunately these men are not criminals. They are vault experts who have gained their "dangerous" knowledge by exhaustive experiments with torch, rod, and pipe upon metal targets, and their names are all well-known. But so cautious is the financial world that it must even take account of the possibility that one of these men may turn criminal!

THE best types of vaults now in existence are not designed to be proof against the fluxing rod and oxygen pipe, for that is impossible. They are engineered simply to delay entrance by an arch-thief as long as possible. Every hour spent in vault-breaking increases a criminal's risk of being caught. One of the strongest vaults in this country might be proof for six hours against the attack of any one of the world's dozen potential super-criminals. And although vault men fear the potential possibilities of the new scientific tools, there are practical objections to their widespread use. They require an immense amount of equipment, an expert technical knowledge.

Moreover, the oxygen pipe generates such intense heat as to be dangerous to use without cumbersome shields. It generates billows of black smoke when it meets cast iron, leading to probable detection—a risk that few criminals would care to run.

Far more likely than an attack on scientifically-designed vaults would be an attempt at breaking into one of the less impregnable strong-boxes throughout the country. Even thick walls of reinforced concrete are not an absolute protection, as a single incident shows.

An unusually intelligent group of crooks hired a garage across an alleyway from a Chicago bank two years ago. They tunneled beneath the alley from the garage, coming up just under the concrete floor of the bank vault. For their final coup they chose the week-end before Memorial Day, which fell on Monday, figuring that their entrance would not be discovered until the bank reopened on the following Tuesday. That would give them time to make their get-away. But an accident upset their plans.

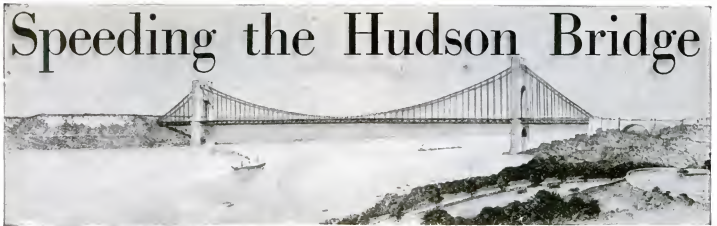
THE cashier of the bank, behind in his work, came in on the Monday holiday. The first thing he saw was a hole big enough for a man's passage ripped through the eighteen-inch floor of reinforced concrete. A plumber's bench had been set up by the audacious robbers, right in the vault, with all the tools necessary for a complete safe-breaking job. When the cashier called the police, they found a tunnel leading to the adjoining garage that would have done credit to a mining expert with its careful shoring of planks. Evidently the burglars had been frightened away just before looting the vault. A few hours more, and they would have escaped with every penny it contained.

The principal reason that one seldom hears of bank robberies today, as formerly is simply the adequacy of police protection. Any vault guarded by police alarms is a burglar-proof vault, just as a papier-mache safe in a fireproof building is a fireproof safe. But in such an emergency as a riot, a revolution, a conflagration, or a strike, there is no substitute for a vault physically buttressed by steel and stone.

CONSIDER, for example, the Boston police strike of a few years ago, when a great city was left without police protection. There is no guarantee against a repetition of such an event. Then picture a rioting, looting mob led by a few expert yeggmen, blowing off the doors of vaults and escaping with fabulous sums of bullion and securities. It is certainly an unlikely picture; but bank officials must consider such possibilities. Probably few of them in Boston slept very soundly during the period of the police strike in that city.

Consequently engineers have been spurred to the design of super-vaults that will stave off safe breakers, if not indefinitely, at least for the few hours that spell the difference between successful thievery and arrest. How successful they have been was demonstrated, in New York City not long ago, when wreckers were actually called upon to demolish newly-built vault. (Continued on page 165)

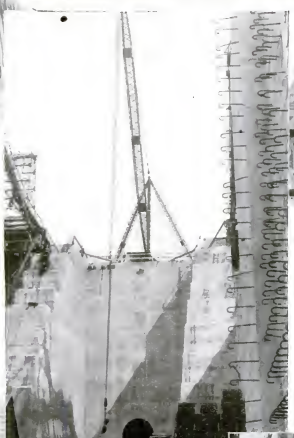
Speeding the Hudson Bridge

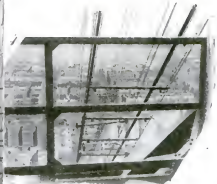


The world's greatest bridge, connecting New York and New Jersey, as it will appear when completed across the Hudson River, probably early in 1932. With a span of 3,500 feet, it will cost $75,000,000.

Swinging in Space

Cable workers being hoisted to the top of the bridge anchorage which rises 200 feet on the New York side. This anchorage is an enormous block of reinforced concrete about 100,000 cubic yards in volume.





A Foot Bridge for Workmen

Bridgemen, working about 400 feet above the river, are seen here placing steel cross supports for a temporary foot bridge for construction of the main cables. The four giant cables, with a carrying capacity of 350,000 tons, will hold a 90,000-ton span, besides enduring all the weight of traffic.

A Giant Arm of Steel

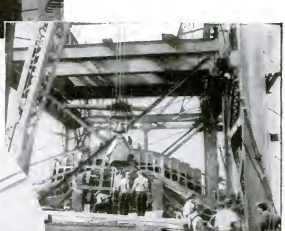
Supported on top of the massive 200-foot anchorage, the crane at the left, with a boom 100 feet long, hoists reels of wire and other materials used in spinning the bridge cables. Observe the massive construction of the anchorage.

Tower and Anchorage

At the left is the New York cable tower, 635 feet high, and at the right, the enormous anchorage block of reinforced concrete. Between them are strung steel ropes with cross supports for temporary bridge for cable workers.

Up in an Aerial Trolley

One of the novel aerial trolley cars, used for the first time in bridge building, carrying workmen from the bridge anchorage to the top of the 635-foot steel cable tower, New York side. The cars, which are suspended from cables, also are used to carry materials.



Atop a Cable Tower

Six hundred feet high on the cable tower, New York side, workmen are seen adjusting the ropes supporting the temporary foot walk. The large steel casting at the center is one of four saddles on which the main cables, each a yard thick, will rest when the bridge is completed. The steel framework overhead supports a traveling crane. During the first year of operation the bridge is expected to accommodate 8,000,000 vehicles with 19,000,000 passengers, in addition to 1,500,000 pedestrians.

Next—Sixteen-Cylinder Autos

Front-wheel drive of new Cord car permits a body design so low that a standing person can look over top.

PRESENT trends in automobile design, such as increased power, front-wheel drive, and streamlines, are discussed here by an expert, who also pictures the car of the future. The author is Assistant Professor of Automotive Engineering in New York University and lecturer on aircraft engines.

By E. H. HAMILTON, B. S., M. E.

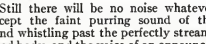
SIXTY years from now, if a man finds it necessary to make a hurried trip, he will step into the form-fitting seat of his waiting automobile, press a tiny button set into the rim of the steering wheel, and, without the slightest sound, glide away from the curb.

Going up a steep ramp a few blocks away, he will straighten out on a wide, glass-smooth, elevated highway that will stretch, as far as the eye can see, in a perfectly straight line.

Then the motorist will press another button. The car will immediately accelerate to a speed of 150 miles an hour so rapidly that the driver will be pressed with considerable force against the seat cushions.

Still there will be no noise whatever except the faint purring sound of the wind whistling past the perfectly streamlined body, and the voice of an announcer coming from a concealed loudspeaker giving the latest stock quotations.

Arrived at his destination, the driver will press another button before descending a ramp to the street level.



THE motor car of today is a truly marvelous piece of mechanism. But that fact cannot cover its faults. It is still much too heavy. It is unnecessarily high, wide, and long. It lacks sufficient power. The transmission, with its hand-operated gear shift, is a nuisance. The starting system, slow and noisy, entails the use of a heavy and not always reliable storage battery. The fuel consumption is extremely wasteful when measured against the theoretical energy contained in the gasoline. Tires puncture, blow out, and wear out. Cars wear out too fast and have to be repaired too often.

This gloomy arraignment of the modern automobile is true only if it is compared with a theoretically perfect car—an ideal which, like many other ideals, may never be attained.

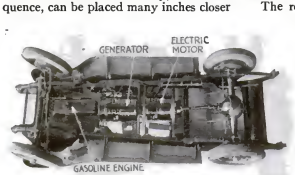
Great progress has been made in eliminating the theoretical defects of the modern automobile, however, and more progress will be made soon. In the matter of height for example, all modern cars are much lower than their predecessors of just a few years ago. Indications of a further trend along this line are found in front drive cars illustrated on these pages. In them the driving power is applied to the front wheels instead of to the rear wheels as has been the universal practice for many years.

It is claimed that this reduces skidding and side sway, but in addition to these features, it certainly permits the construction of a much lower body. Eliminating the rear axle housing and the necessity for making the rear axle straight and in line with the centers of the rear wheels allows the construction of an offset rear axle. The body, in consequence, can be placed many inches closer to the ground without bumping against the axle on rough roads.

It is claimed, too, that the front-wheel drive reduces unsprung weight and therefore improves riding qualities. Unsprung weight is the weight of all parts rigidly attached to the axle. Sprung weight is the weight of all parts connected to the body and frame in such a way that the springs are interposed between the weight and the wheels. The ideal car would have no unsprung weight; that ideal, is, of course, unattainable since the wheels and tires must have some weight.

THE front drive reduces unsprung weight by eliminating the bulky and heavy rear driving axle. The differential gear in the front axle is part of the motor unit, with universal joints in the two short shafts which drive the front wheels. Reducing the unsprung weight simply means that a greater proportion of the total weight is cradled by the springs instead of being bounced along the road on the wheels.

The reduction of the total weight of a car is important, first, because less weight means less wear on the tires; second, because the car will climb hills better and accelerate faster with the same power. The use of new types of steel and new methods of fabricating steel have made it possible to reduce the weight of cars, and it is



Power plant of the gas-electric auto. Its electric transmission eliminates the shifting of gears.

New gasoline-electric drive car developed by General Electric engineers and Rauch & Lang.

possible that the introduction of the new metal, beryllium, in commercial quantities at reasonable prices will permit a still further reduction.

In power and speed, present automobiles far surpass those of a few years ago. Five years ago few could go sixty miles an hour. Now almost every one can do between fifty and sixty, and many stock cars will travel as fast as seventy-five or eighty.

THE use of larger valves, better manifolds, higher compression, and lighter and stronger engine parts has been responsible for the great improvement in speed, power and economy. This improvement in the performance of the cheaper cars has brought about a curious situation. The larger and more expensive cars no longer can out-perform their less expensive brothers on hills or in accelerating in traffic. Roughly speaking, all cars now are on an equal basis, if cylinder capacity in proportion to weight is considered. At first glance the solution for the heavier and more expensive cars would seem to be to use larger cylinders, but that is not practicable. There is a certain definite limit in cylinder diameter and in length of stroke beyond which it is not practicable to go without increasing vibration and excessive wear.

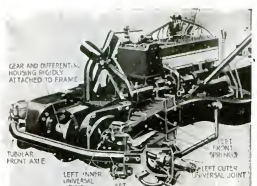
It seems logical to predict, therefore, that soon high priced cars will be fitted with twelve and even sixteen cylinders. By increasing the number of cylinders and holding the bore and stroke the same, or even reducing them somewhat, the available power is increased far more than is the weight.

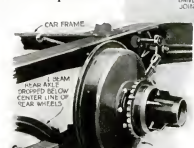
Indeed, it is reported that the manufacturer of one of the cheapest American cars would be glad to replace his present motor with an eight-cylinder model if he could design one that suited him. The advantage, of course, would be smoother running, greater acceleration, and perhaps even better economy and wearing quality.

Some day an engineer will develop a type of transmission that is noiseless and that has no gear shift lever. Theoretically, such a transmission is possible either by hydraulic pressure or by electromagnetic means. Both systems have been tried several times but with no success, either because of excessive weight or unreliability. The latest and most practical development in transmissions seems to be in the direction of eliminating the clashing of gears, which is, of course, a notable improvement.

Since the electric self-starter was first applied to the automobile there have been no major improvements along this line. The ideal method—a car designed so that pressure on a button would start the motor immediately and noiselessly—seems as far away as ever. Perhaps some radically different method will be invented to supplant the present system of a starter motor operating from a storage battery.

Modern four wheel brakes, in good condition, so closely approach ideal operative results that there is room for improvement only in making them more durable and more easy to apply, and perhaps adding some method of button control.





Front of the Cord chassis. The power is transmitted to the front wheels through short shafts to each wheel. Left: Offset rear axle of the Cord, which brings the body closer to the ground.

Startling improvements are bound to come in fuel economy. Charles F. Kettering, famous automotive engineer and President of the General Motors Research Corporation, predicts eighty miles to the gallon of gas. (P.S.M., Sept. '29, p. 32). The car would have to be very light and the motor very small, operating at the top limit of high compression and at relatively high speed. Unfortunately, a car built along such lines, while extremely economical, would not have the performance demanded by the present-day motoring public. The problem is, therefore, to combine economy with speed, hill-climbing ability, and comfort.

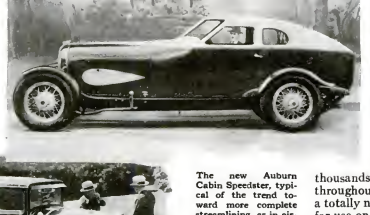
Gasoline consumption rapidly increases with increased speed, because of the increase in power required. If, for instance, it takes a certain quantity of gasoline to drive a car thirty miles an hour, it will take at least twice that quantity to drive it the same distance at sixty miles an hour. This increased gasoline consumption at high speed is not due to internal friction in the motor or in the parts of the car, but to air resistance. It can be overcome only by careful attention to the streamlining of the car, perhaps along the line of the modern high speed roadster pictured here. Perhaps the car of the future will have a body shaped much like an airplane fuselage, with only a small portion of the wheels protruding below the body and no external mudguards or windshields to cause air resistance.

The lessons learned from the performance of Major H. O. D. Segrave, who drove his *Golden Arrow* at a world record speed of 231.36 miles an hour (P. S. M., June '29, p. 46), undoubtedly will affect the future development of cars designed for high speed road work.

Modern tires last, on the average, at least three times as long as tires produced only a few years ago. Part of this increased durability is due to the tire construction, but at least a portion of it is due to the improved roads over which the tires roll.

The invention and development of the automobile was responsible for great changes in methods of road construction, and for the building of thousands of miles of concrete highways throughout the country. It may be that a totally new type of car will be developed for use on these perfect highways—a car practically without springs because there will be no bumps.

In the matter of durability and freedom from troublesome repairs, the car of today is far superior to the car produced years ago. It is hard to predict, however, just what the future will produce in the way of durable cars, for, if automobiles are never to wear out, where are the manufacturers to sell the millions of cars they now produce annually?



The new Auburn Cabin Speedster, typical of the trend toward more complete streamlining, as in airplane design, to reduce wind resistance.

Another new front drive car, the Ruxton, stands in the foreground beside a car of conventional design. Note the difference in the height of the cars.

Back of the Month's News

By

KARL VOOGHT

BY PROCLAMATION of the President of the United States, the great dam across the Colorado River at Black Canyon on the boundary line of Nevada and Arizona, usually called the Boulder Canyon Dam, is to be built. There are still some legal difficulties, notably one about the consent of Arizona to the allocation of water between that State and California, but these are expected to be ironed out. The dam will be the greatest in the world, with a height of 677 feet above bedrock and a storage capacity of 26,000,000 acre-feet of water, something over seven cubic miles (P. S. M., Oct. '29, p. 60). It will develop power and provide water for irrigation. But neither of these objects is the chief reason for building this gigantic storage plant.

The volcanic cliffs of the Black Canyon, where the great Boulder Dam will be constructed across the Colorado River to a height of 677 feet.

That reason is the growing necessity for regulating the Colorado River. Of all great rivers, the Colorado is perhaps the muddiest. This means a grave danger when the water of the river is used for irrigation. Ditches fill up with the silt; the level of the river bed itself is raised; sooner or later the water will not run into the ditches or escape by itself in some new channel, as the Colorado did twenty-five years ago when the Salton Sea was formed. Furthermore, the Colorado is exceptionally subject to floods. At one season there is more water than can be used for irrigation, so that millions of gallons run to waste into the Gulf of California. At another season, on the other hand, there is too little water and valuable crops are consequently ruined. During the nonflood season the river may run almost dry.

A SERIES of dams and settling basins along the river's course would cure all this. The flow could be regulated at all seasons to an even quantity sufficient for irrigation. Most of the silt could be settled out in the basins. For years engineers have planned the complete control of the river in this way, taking into account its entire length from the crest of the Rockies to the Gulf. The Boulder Canyon Dam, with its enormous storage capacity, is the first step of the plan.

Virtually no water will be taken from the dam itself for irrigation. Its purpose is storage, not to lift water to fill high-level canals. The irrigable land and the intakes of canals to supply it are farther toward the river's mouth. Water allowed to escape through the dam will be used to produce power but that, too, is incidental. It cannot be transmitted economically to any industrial area. Some will be used, doubtless, by industries which spring up at the dam site, but much may be used to pump a part of the river over the mountains to Los Angeles.

Southern California is rapidly running out of water. Population and industries have increased enormously. Rainfall is not great and no great rivers, except the Colorado, are available. Californians are planning, therefore, to take part of the water of the river, using a third of a million or half a million horsepower from the dam to drive gigantic pumps, and thus to lift a good-sized river of Colorado water over a rise of more than a thousand feet to a point from which it can be made to flow down to Los Angeles through a great artificial canal.

Life Growing Shorter

THE road back to Methuselah is hard to find. Sanitary science has conquered disease after disease. Surgery now saves thousands of patients whom it would have had to let die fifty years ago. Marvelous cures are effected in American hospitals so regularly that no one thinks of recording them. Yet the average age of American adult life is decreasing instead of increasing. A man now has even less chance to live to be older than the traditional three score and ten than did his grandfather a half century ago.

SO SAYS Professor C. H. Forsyth, of Dartmouth College. For more than a decade Professor Forsyth has studied the statistics of births and deaths in the United States. They do not bear out the optimism of health officers, he finds, except for young children. Infant deaths have been greatly lessened under the efforts of modern medicine, especially the successful effort to conquer the germ diseases of infancy formerly so much dreaded under the name of "summer complaint." For a baby of today at the moment of birth, the expectation of life calculated from the statistics is greater than a generation ago. But that is not true for a child of ten, after the former dangers of infancy have been passed. Still less is it true for a person already thirty or forty years of age.

What every individual wants to know is, of course, the date of his own death. No statistical method can tell him that; nor any other method that science now knows. Even people given up by the doctors have been known to get well. What the statistics do tell is the age to which the average individual will live. It is this, computed for persons already past infancy, that Professor Forsyth's curves show. If you were the average man fifty years old in 1926 you could expect to live to be sixty-nine. A man fifty years old in 1890 could have expected to live to be at least seventy-one.

INFANCY is less fatal nowadays; adult life is more fatal. Why? Professor Forsyth mentions three conceivable causes: city life, faster living, and increased strain on the adult heart. All might be combined, he implies, in the habit of adults not to take care of their health or to obey the orders of their doctors, as children must obey.

People born in the world may be considered to have a certain reserve of life and health; some great, some small. In former days weak individuals with small health reserves were apt to die in infancy. Now these weaker folks are kept alive through that first danger period, but die relatively early in adult life. This would lower the life averages in exactly the way that Professor Forsyth finds. Perhaps the fifty-year-old in-

dividual today who is as strong and healthy as his grandfather was at the same age has the same or a greater chance of long life. It is only the weaker, perhaps, who die younger. But to tell with assurance whether this is true or not needs much more accurate data than now exist.

Minerals as Peace Makers

ENGLAND and the United States have it in their power forever to prevent war. They need only deny to any war-making nation the supplies of minerals and mineral products which that nation must import. That statement was made by Sir Thomas Holland, President of the British Association for the Advancement of Science, at the meeting of the association which was held recently in South Africa.

Mining engineers, not traditional statesmen, may guide international policies of the future. Nor has it escaped the attention of commentators that the United States, chief of mineral-producing countries and, jointly with England, guardian of nearly all the minerals of the world, now has a mining engineer at its political helm.

In the last twenty-five years, Sir Thomas stated, more minerals have been mined and used than in all the previous history of the world. But this sudden conversion of civilization into an age of ores and minerals is reinforced by a change in metallurgy. Mining operates continually on lower-grade ores and in larger units. The day of the small miner is almost over. Even diamonds are now mined by great corporations, using gigantic labor-saving machines. The result, Sir Thomas said, is that mining grows ever more local. There is only one great region of diamond mines in the world; only a few great iron mines and great copper mines.

The country which possesses one of these great mines has too much of that one mineral, but usually too little of others. Commerce in minerals has become an essential of civilization. This provides both an incentive and a means to prevent war. War stops this mineral commerce and might destroy the whole civilized structure. But England and the United States control, between them, nine tenths of the world's coal, two thirds of its copper, ninety-eight percent of its iron. All that is necessary is to add to the Kellogg treaties, Sir Thomas says, a provision against exporting minerals to any country that wages war. Automatically, war will be abolished.

But for how long? The present tremendous use of minerals means, as many engineers have pointed out, the ultimate exhaustion of world supplies. Some day even the great mines will be worked out. What will happen then? Sir Thomas made no prophecy, but one seems possible. When mines are gone, metallurgical sciences will have to turn to sources more widely distributed. Aluminum will be made from any clay bank. Iron will be extracted from any mountain of dark-colored, iron-weighted lava. Suitable processes for these feats will be invented.

Nations once were self-sufficient, Sir Thomas said, because they produced everything they needed. Now they are not self-sufficient, because there are so few mines of minerals in the world and no nation, not even the United States, owns mines of every mineral it needs. But when needed mineral elements can be extracted from ordinary rocks or made synthetically in the laboratory, national self-sufficiency may return.

Sorting gems from the famous Litchenburg diamond mines in the Transvaal, South Africa. Below: Miners at work in the thirty-mile diggings. Diamonds now are mined on a large scale by great corporations, which employ labor-saving machinery to a very great extent.

One of the world's oldest diggings—a turquoise mine worked by Egyptians as early as 4,000 B.C., and still exploited by Arabs. Some day all mines will be worked out.

Thumping Atoms

IT IS easy enough to broadcast thumps over the radio. Before studios were draped and carpeted to avoid such accidents, thumping noises used to go out over the ether every time a visitor walked carelessly across the floor. But listeners to WGY were entertained a few weeks ago by an unusual kind of thumps; by the noises made by flying atoms when they entered a special electric apparatus connected to the radio transmitter.

Radium and other radioactive elements continually shoot out streams of atomic particles flying with speeds of over ten thousand miles a second. If a bit of radium is held in the fingers, these atomic projectiles enter the flesh. That is one way that radium causes serious burns. Several years ago a German physicist named Geiger invented an apparatus to collect and count these shooting atoms. Each tiny particle is passed through a thin window of aluminum, the speed of the atom being so great that it shoots through without being stopped and without damaging the metal. Inside is a small chamber containing a few atoms of gas. Some of these gas atoms are electrified by the atomic projectile, so that the gas becomes for an instant a conductor of electricity. Connected to the chamber is a vacuum tube amplifier, which amplifies millions of times the tiny pulse of electric current produced by the arrival of the atomic bullet, until it can affect a loudspeaker.

THAT is the "atom counter." Its loudspeaker was placed close to WGY's microphone. A bit of radioactive material was brought close to the aluminum window. Each flying atom that entered the window created a loud thump in the loudspeaker. That is what was broadcast.

Science has more useful employment, of course, for these atom counters. They can be used to measure the amount of radio-

The great ruins of Zimbabwe in southeastern Africa, showing the massive stone walls and curious round tower, now believed to have been constructed some 1,400 years ago by a vanished race.

active material in a specimen of ore or other material. With them it is possible to measure the direction, intensity, and changes in beams of atomic particles. Conversions of one radioactive element into another can be detected.

There are other atomic noises, too, which modern apparatus makes audible. A year or so ago, for example, Dr. H. Clyde Snook demonstrated the noises created in a bit of iron when the atoms turn over as the iron is magnetized.

How Much Do You Know About the Movies?

Test your knowledge with these questions, chosen from hundreds asked by our readers. Answers are on page 156.

1. How do they take "slow movies" of jumping athletes?
2. How is sound recorded on the film for talking pictures?
3. Why must a motion picture machine be put in a fireproof booth?
4. How can they take motion pictures by moonlight?
5. Why can't an enlargement from a motion picture film be made as clear as the picture on the screen?
6. Why does the voice in the "talkies" always seem to be a little behind the motion of the speaker's lips?
7. How do the actors in slapstick comedies run so fast that they disappear in the distance in a few seconds?
8. If motion pictures are just a series of still pictures, why don't we see a row of still pictures moving across the screen?
9. Why do they develop home movie film and then reverse it to a positive instead of printing a positive?
10. Where is the best location in a theater for viewing a motion picture?

A Lost Race of Builders

IN SOUTHEASTERN Africa lie the famous ruins of Zimbabwe; massive stone walls, curious round towers also of stone, apparent remains of former streets, and other relics of unknown origin. These ruins are said to have supplied the stimulus for the legend of King Solomon's Mines. That famous monarch is believed to have sent expeditions long distances to bring back gold, gems, and precious woods for his buildings at Jerusalem. When one finds in the heart of Africa ruins of some once powerful and populous city, what is more natural than to imagine that Solomon may have had a hand in building them?

It is the habit of archeology, however, to put such notions to the sure test of the spade. Some months ago a distinguished British archeologist, Miss Gertrude Caton-Thompson went out to Zimbabwe with two women assistants, to see what the spade would reveal. Trenches were dug this way and that through the ruins; deeper, in some instances, than the deepest foundations of the walls. Many tools and other objects were found, but none relating to King Solomon. Instead, the conclusion was reached that the towers and walls were erected not more than 1,400 years ago by some African race and kingdom which was in commercial touch with the Europe of the Middle Ages. Some of the objects found down at the deepest levels obviously came from European countries of perhaps A. D. 600.

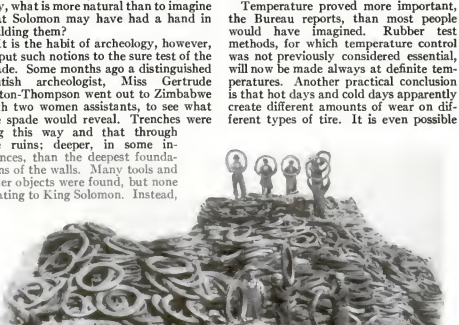
Solomon being eliminated, African archeologists now find themselves confronting a new problem. Who were these people able to build stone cities in the heart of Africa when not a score of men in England owned anything better than a rude stone hut?

Other ancient civilizations, lost to history, have been recovered by modern scientific excavation. The Sumerians, who preceded the Babylonians, furnish one example. Another is the forgotten empire of the Biblical Hittites. Now Miss Caton-Thompson brings another from Africa.

Making Tires Live Longer

THE thing which Americans used to wear out in the largest quantity was probably shoe leather. Now it is rubber tires. Industry begs for a genius who can make one tire last as long as two. Much progress has been made, as any old-time motorist will realize if he recalls the mileage he got out of a tire twenty years ago compared with that he gets today. This improvement is due largely to scientific research, some of which has been done at the United States Bureau of Standards. Recently the Bureau's rubber experts took a new step, by testing the effects of different temperatures on the wear of tires and of other types of rubber.

Temperature proved more important, the Bureau reports, than most people would have imagined. Rubber test methods, for which temperature control was not previously considered essential, will now be made always at definite temperatures. Another practical conclusion is that hot days and cold days apparently create different amounts of wear on different types of tire. It is even possible



A great pile of discarded automobile tires at Cambridge, Mass.—just a small portion of the annual rubber waste in the United States, which scientists are trying to save by laboratory research.

that eventually special hot-weather tires and special cold-weather ones will be used at the proper season to diminish the year's average wear.

To the scientific man rubber is one of the most interesting materials. Belonging to the class of gluelike, uncrystallized materials called colloids, rubber nevertheless discloses, when examined by X-rays, internal regularities in arrangement of the atoms; a line of investigation in which the German expert, Dr. E. A. Hauser, has been especially successful.

It is probable that rubber stretches by virtue of an ability of these atoms to slip past each other a little without breaking apart, and to pull themselves back again when the stretching force relaxes. Doubtless the relations of these invisible atoms inside the tread of a tire are responsible for a lot of the temperamental qualities of rubber, including the Bureau's newly-discovered effects of temperature.

Eighty-five percent of the crude rubber used in the United States goes into the making of tires. According to the Rubber Association of America, nearly 80,000,000 new tires were added in 1928 to those already running on American roads. It is estimated that between thirty and fifty million automobile tires are discarded each year. Beside the need for longer wearing tires is the need for a simple plan to redeem this annual waste.

Magnetic Pole Wabbles

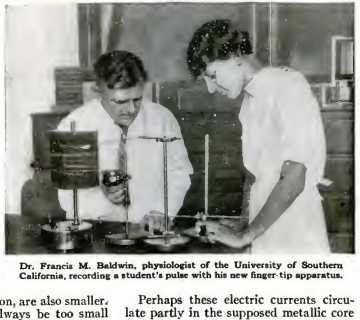
THE nonmagnetic ship, the *Carnegie*, pictured above, now on a world cruise for the Carnegie Institution of Washington to obtain data about the magnetic and electric forces which surround the earth, has obtained definite proof, it is announced by Captain J. P. Ault, that the north magnetic pole toward which the compass needle is supposed to point is not a fixed spot on the earth's surface but more than a few hours at a time, if that. The magnetic pole wabbles even more widely and less regularly than does the geographic pole marking the end of the earth's axis.

For practical purposes this magnetic wabble probably makes little difference. The slow change of the compass direction from year to year is important to surveyors and navigators, but this change has been known for years and tables are issued by the world's observatories showing just what compass direction is normal for a certain city or a certain spot on the ocean in a given year.

The magnetic wabbles discovered by the *Carnegie*, although more rapid than these slow changes in the compass direction, are also smaller. Probably they will always be too small to bother the practical sciences, for the magnetic compass is never depended upon for more than an approximate direction. When accuracy is needed both surveyors and navigators observe the stars.

Even the slightest variations of the earth's magnetic forces are important, however, to scientific men striving to discover the long-sought secret of why earth magnetism exists. It is impossible to think of any great mass of magnetized iron inside the earth, for the planet's interior is hot, and hot iron will not retain magnetism. At the Naval Research Laboratory in Washington, Dr. Ross Gunn, Dr. E. O. Hulburt, and their associates form probably the most active group of workers on these problems. Their fundamental idea is that earth magnetism is due to currents of electricity circulating around the earth.

Measuring electrical variations in the atmosphere above the sea with a special instrument aboard the nonmagnetic ship *Carnegie* (in circle), now on a world cruise to gain new knowledge of forces surrounding the earth.



Dr. Francis M. Baldwin, physiologist of the University of Southern California, recording a student's pulse with his new finger-tip apparatus.

Perhaps these electric currents circulate partly in the supposed metallic core of the earth, perhaps they are in the crust, possibly they are in the electrified region of the upper air familiar to radio fans as the Heaviside Layer. They may flow in all three of these places, the actual magnetic forces representing the combined effects of all the currents. Detailed studies like those being made on the *Carnegie* may soon permit a more complete analysis of these forces and a more exact theory of earth magnetism.

Machine Records Pulse

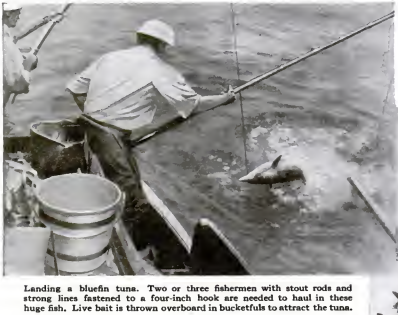
IF ONE holds the tip of one finger with the thumb and a finger of the other hand, and his sense of touch is delicate enough, he will feel the imprisoned finger-tip beating, stroke by stroke, with the throbbing of his heart. With every heartbeat blood is driven down the arteries of the arms to swell each thumb and finger slightly. A Los Angeles physiologist, Dr. Francis M. Baldwin, of the University of Southern California, has devised an instrument which not merely detects the beating pulse felt in a fingertip, but writes a record of it on a chart.

The ball of the finger rests on a small metal support. Against the nail presses another metal button, connected to a delicate lever. Each time the finger swells with a pulse beat the nail lifts a trifle, like the lifting chest of a sleeper as he breathes. Each tiny lift is magnified by the levers and recorded as an upward surge of a wavy line drawn on a smoked, revolving drum or in ink on a moving chart. On the same record a clock makes a series of ticks, one each second, so that the rate of the finger pulse may be counted from moment to moment.

Physicians no longer lay much stress on the actual number of heartbeats per second. Not long ago Dr. E. P. Boas of Montefiore Hospital, in New York City, devised a heartbeat recorder which the patient can wear for hours at a time, even when asleep. With this device Dr. Boas showed that the heart rates of perfectly normal people vary more than fifty percent from time to time, depending upon what the person is doing or thinking. Yet the pulse beat in the wrist or the finger still (*Continued on page 142*)

Three Men to Hook One Fish

How a Fleet of Hundred-Foot Craft Hunts the Great Tuna a Thousand Miles Out to Sea



Landing a bluefin tuna. Two or three fishermen with stout rods and strong lines fastened to a four-inch hook are needed to haul in these huge fish. Live bait is thrown overboard in bucketfuls to attract the tuna.

A derrick was required to hoist this 650-pound tuna fish from the fishing boat to the wharf.

By CAPTAIN TONY ROSATO

Captain Rosato is master of the fishing boat Buena Ventura, *and has been going after tuna out of Pacific ports for twenty years.*

SIXTEEN million dollars' worth of tuna fish was brought into two southern California ports last year by a fleet of approximately 100 fishing boats operated by about 1200 men. Two or three men, sometimes four, were required to catch each one of the thousands of huge fish. The fleet, entirely motor-driven and wholly refrigerated, presents a new type of fishing craft. Each vessel contains every modern device and costs from $75,000 to $110,000.

From May of each year to January of the next, this fleet ranges 1,000 to 2,000 miles southward from the two home ports of San Pedro and San Diego, standing along the shores of Mexico and Central America, 500 to 1,000 miles out to sea. Returning, each boat carries from 100 to 175 tons of yellowfin, bluefin, or striped tuna or albacore. They remain at sea from thirty to sixty days at a time, being unwilling to land at any Latin-American port, unless disabled, because of the excessive duty on fish imposed by the southern republics. To preserve the catch until the home port can be reached, the boats are equipped with small, almost automatic refrigerating systems which keep the fish tanks and their contents at the temperature of the crushed ice in which the tuna are packed as soon as caught.

The boats, eighty to 120 feet long and twenty to twenty-eight feet in the beam, are driven at a speed of ten to thirteen knots by 200 to 450 horsepower Diesel engines. Their fuel tanks hold sufficient oil for a 5,000-mile run. Auxiliary gasoline and oil engines generate electric current for lighting, heating, and cooking; for cargo and anchor winches; for refrigerating plants both for the caught fish and for the food supplies; and for bilge and other pumps.

Hooks and lures used to catch tuna. Feathered hooks in the center rows are used most.

With good luck, a boat will return to port with from 100 to 175 tons of tuna fish, worth about $120 a ton. The *Hermosa*, one of the largest of the tuna fleet, made a 4,400-mile round trip from San Pedro to La Union, in Salvador, last summer, and returned with a capacity cargo of 225 tons, worth $27,000. She was out approximately fifty days. My boat, the *Buena Ventura*, encountered a large school of tuna only five days out, taking a capacity catch of 100 tons for only ten days' time.

SUCH short and successful voyages, however, are rare. Fishing for tuna is the greatest gamble of all the commercial fisheries. One boat, costing $92,500, paid for itself in two years; others have made as many as five thirty-day trips without a penny profit, bringing back just enough fish to pay expenses. Like gold, the tuna is where you find it, and the search may be long and costly. The tuna are moving farther and farther from the coast of the United States, and are now to be found in numbers only in waters beginning 800 to 1,000 miles south and extending to and below the equator, no one knows how far.

Leaving San Diego or San Pedro, the first stop of the tuna fishing boat is about 300 miles down the coast of Lower California and 100 to 150 miles out at sea. There, the great *lampara*, or fine-meshed net, is lowered to take up the supply of live bait, mostly anchovies, sardines, and similar small fish. The *lampara*, often 1,200 feet long by 120 feet wide, catches ten to fifteen tons of bait at one time.

The schools of anchovies are found in the daytime by the hordes of gulls and other sea birds which follow them, and at night by the phosphorescent glow which envelops them. This glow—known as

"red water," "blue water" or "yellow water"—is caused by the presence of myriad microscopic creatures (dinoflagellates), and the schools, often twenty to fifty acres in extent, become moving lakes of cold fire visible on moonless nights for distances up to seven miles. When the fish are caught under such conditions, the seine, the hull and oars of the skiff, and the long rubber boots of the fishermen become rainbow hued.

AS THE net is filled, it is lifted by electrically driven boom and tackle and emptied into large bait tanks, built on deck, which hold as much as 100 tons of live bait. Electric pumps keep tanks about half filled with sea water. Screened valves let out just as much water as is pumped in, so that constant circulation of new salt water is maintained at all times. Fresh mackerel, ground fine, is fed to the bait fish.

With the bait tanks full, the tuna boat drives southward at top speed for the general rendezvous of the fleet, off Cape San Lucas, the southernmost end of the Mexican peninsula of Lower California. Unless the tuna are running very well, the fisherman will find there fifty to one hundred "hook-and-liners," or "bait boats," as they are variously called, and twenty to thirty "purse-seiners." The latter are slightly smaller boats, which take tuna in very large, coarse nets, drawn through the schools.

Schools of tuna fish may be met anywhere from 200 miles north of Cape San Lucas to an unknown limit in the south Pacific. They usually remain 100 to 1,000 miles off shore, near banks or low islands surrounded by shallow water, and always are moving northward, though where they go when they reach their northern limit of migration, no one seems to know. When a school is sighted, with the great fish leaping and playing over the water, the bait tanks are opened, steel gratings or platforms are dropped over the sides along the gunwales, and the rods are taken down for action. The platforms are about six feet long by three wide, and usually there are three on each side of the vessel and one at the stern. Two or three men can stand on each platform, which is lowered until it all but touches the water. If the fish are running large—100 to 250 pounds—three men are assigned to each platform; if small—twenty to 100 pounds—two are sufficient.

The rods, of bamboo, are two inches thick at the base and about ten feet long. Each man has a rod, with a line slightly shorter than the pole; these lines are brought together through an iron ring and fastened to one hook. This hook, covered with white feathers, is about four inches long and has no barb, to expedite removal of the hook. Each hook is covered with white feathers, being, in fact, a huge trout fly. It is called a "squid." With two men on each platform, both of their lines running to one "squid," fourteen men can fish at one time from the larger boats. This leaves the skipper and the cook to handle the ship. The captain takes his place at the wheel, and the cook, with two large pails, starts "chumming." This consists in dipping live bait from the tanks and scattering it far and wide over the water alongside and astern of the boat, which, meantime, has come about and is moving in the same northward direction as the tuna, and at a approximately the speed of the mov school—about six miles an hour.

When the bait has attracted the tu to the vicinity of the boat, the fisherm drop their hooks overboard, draw them slowly through the water in t direction in which the boat is movin The tuna are to be seen plainly in t water, dashing ahead, leaping, but ways moving steadily northward. Wh one seizes a squid, the two men on th rods heave the fish inboard, trying to tak advantage of the forward rush to hel them get the weight over the gunwal and onto the deck. Since the hook barbless, the strain on the line cannot b relaxed for an instant, or the fish is lost But when the tuna has been lifted to th deck, a flip of the hands on the rod re leases the squid in a second, and th lure is ready for another fish.

Lifting two 350-pound tuna fish from the hold of the author's boat, the *Buena Ventura*.

Part of a catch of a hundred tons of yellowfin and striped tuna fish, brought in by one boat and sold to the cannery for $120 a ton. The boat, with a crew of ten, was out only thirty-two days.

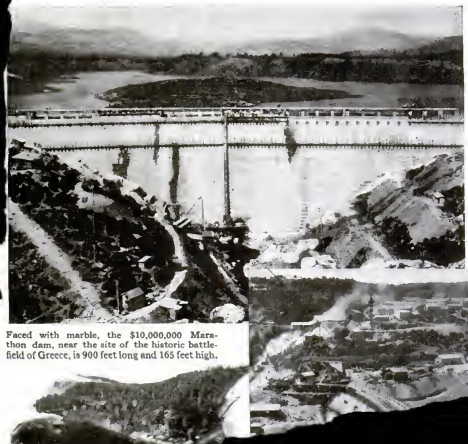
SOMETIMES herds of sea lions sur round a boat and eat the bait as fas as it can be thrown overboard. They ar a real problem to the fishermen, since they not only eat the "chum" but drive away the tuna as well. On one voyage, I had with me the skipper of another boat, which was in a San Diego yard undergoing repairs. A herd of about fifty young bull sea lions surrounded the *Buena Ventura*, so enraging this skipper that, sanding his hands from the boxes on board, he lay down on one of the platforms, seized a 150-pound sea lion by one flipper and the tail as the animal swam close to the boat, and heaved it inboard. The barking of the captive so startled and frightened the herd that they all swam away.

This "lion" was a young bull weighing about 150 pounds. He became so tame that he would follow us about the deck like a dog, never tried to escape, and was brought back to San Diego, where he was sold to the trainer of a troupe of performing seals.

AT ANOTHER time, we were fishing off the tip of Cape San Lucas. Two men on the stern platform hooked a tuna, lifted it clear of the water, and on the instant of swinging in inboard were astounded to see a huge body rise from the sea, a cavernlike mouth open, and their tuna and hook disappear. A body twenty-five feet long followed the head, and the creature, describing a loop like that of a porpoise, dropped from sight. Fortunately, the men had presence of mind enough to let go their rods; otherwise they would have been pulled off the platform and probably lost. We saw several of these sea highwaymen later and found them to be whale sharks, ranging up to forty feet in length. A fifty-pound tuna is merely a bite to one of them, and their great jaws could slash a man in two at one cut.

When the decks are filled with tuna, say twenty-five or thirty tons, half of the men quit fishing and turn to packing the cargo in the tanks. The entire interior of the modern tuna boat is insulated with five inches of cork, and divided, with the exception of the engine room and the chain locker in the forepeak, into the fish boxes. Before the boat leaves its home port, these tanks are filled with crushed ice and (*Continued on page 148*)

The World's Only Marble Dam



Faced with marble, the $10,000,000 Marathon dam, near the site of the historic battlefield of Greece, is 900 feet long and 165 feet high.

ican engineers to be in excellent condition, attesting the great skill of the ancients as engineers.

During the rise and fall of the Roman Empire, through the days of Herodus Atticus, Constantine the Great, Julian, and Justinian, the Hadrian Aqueduct performed its silent task. Then came the invasion of the barbarian Goths, the Vandals, the Slavs, followed by the Dark Ages, the Renaissance, and the Turkish occupation. During these centuries the aqueduct fell into disuse and was forgotten until the Greeks regained their freedom a century ago, when it was rediscovered.

THE new dam, which is faced with white marble quarried from Mount Pentelicus, is a solid concrete wall 150 feet wide at the base and fifteen feet wide at the top. It is 900 feet long and rises 165 feet above the river bed and 695 feet above sea level. The structure contains more than six million cubic feet of concrete and masonry, 40,000 tons of Portland cement

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Lifting two 350-pound tuna fish from the hold of the author's boat, the *Buena Ventura*.

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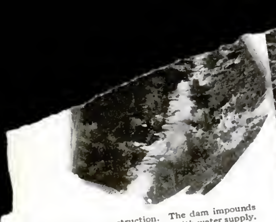
traffic acro-

The dam captures the waters of the Haradra and Varneva Rivers which formerly flowed into the Euboean Gulf, and forms the artificial Lake of Marathon which, when full, will have an area of more than 25,000,000 square feet. In some places the lake will be more than 150 feet deep, and it will have a capacity of more than a billion cubic feet of water.

In the construction of the Marathon Dam about 5,000 Greek laborers were employed. Numerous roads were built, as Marathon is in a semiwild



The site of construction. The dam impounds two rivers to provide Athens with water supply.

A view of the work from above, showing cars hauling concrete along the top. Quarry and construction camp are in the distance.

CLOSE to the historic battlefield at Marathon, where the Greeks defeated the Persians in 490 B.C., American engineers are putting the finishing touches on the first and only marble-faced dam in the world.

When the Marathon Dam is turned over to the Greek government early in 1930, the city of Athens, for the first time since its foundation in 1259 B.C., will have an adequate water supply.

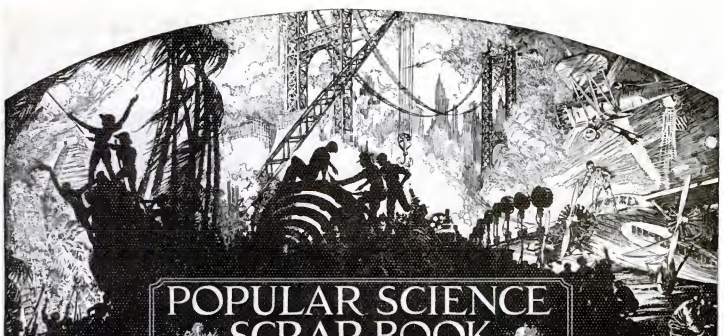
Work on this great project has been in progress since late in 1925, when the contract was let to an American concern. At that time the Hellenic Republic authorized a $10,000,000 bond issue to provide a large storage lake in the Parnes Mountains, near the village of Marathon, which could be created by erecting a big dam across the Rivers Haradra and Varneva; to transport these waters in a gravity aqueduct passing under the Parnes range to a storage reservoir in the Attic plain near Athens, and from this reservoir to distribute the water to Athens, Piræus, and the Phalerons.

In performing their contract with the Greek government the American engineers utilized some of the water supply systems which have been in use for centuries. One of these was the Hadrian Aqueduct, named after the illustrious Archon Eponymos Hadrian, who commenced work on it in A.D. 134 during his term as Governor of Greece, before he became Roman Emperor. It was completed by his adopted son and successor, Antonius Pius, in A.D. 140. This aqueduct is fifteen and one-half miles of masonry-lined tunnels at depths of from thirty to 130 feet below the level of the ground. After having been in use more than 1,800 years, many miles of it were found by the American

country. A new dock was built at the port of Chalkis to handle the huge shipments of machinery, cement, and other supplies. At Kastri, a small village between Athens and Marathon, a 1,320-horsepower Diesel plant was installed to deliver electrical energy to the main job over a 15,000-volt transmission line.

The American engineers had considerable difficulty introducing American working methods in Greece. At the outset the Greek workmen insisted upo[n] their usual three-hour siesta from noo[n] until three o'clock. Gradually howeve[r] they have been persuaded to adopt th[e] American period of one hour.

The Greek government is planning [a] huge celebration at the dedication of t[he] dam, early in 1930.



ON the following pages are presented a month's record of invention and brief bits about the new, interesting, and unusual things people are doing in all parts of the world.

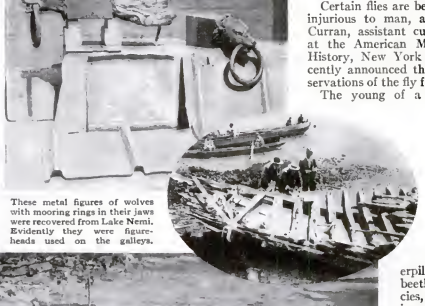
Mad Emperor's Galley Emerges after 2,000 Years

TIMBERS of a vessel that carried the mad Roman Emperor, Caligula, 2,000 years ago recently emerged from the water of Lake Nemi, Italy. For many months, the Italian government has been pumping water from this mountain lake, known as "Diana's Mirror," in an elaborate engineering project intended to rescue two ancient galleys, and the treasures they may contain, from the lake bottom. More than two thirds of the smaller ship, at this writing, was projecting from the water. It was expected to be high and dry by the end of October. Examination of the wood composing the timbers shows them as solid as they were when the galley was sunk before the birth of Christ.

It is in the second galley, deeper in the lake, that archeologists expect to find treasures of art. The first galley has been the object of numerous treasure hunts in the past and much of its contents is known to have been removed.

In 1447, a Roman Cardinal attempted to lift this galley. He hired "men who swam like fishes," to dive and attach heavy chains. But the chains snapped or tore loose when the Cardinal attempted to lift the boat. His booty was only "enough timbers to load two mules." Later, after several other fruitless attempts to lift the sunken boats, an antique dealer hired divers with modern suits to bring the art work of bronze and stone to the surface.

The legend of the sinking of the two boats relates that the insane ruler during a revel had slaves chop holes in the hulls and then was taken ashore to watch his drunken guests carried to the bottom. An examination of the remains, when the boats are removed from the lake, is expected to offer direct evidence as to the truth of this old story.



These metal figures of wolves with mooring rings in their jaws were recovered from Lake Nemi. Evidently they were figure-heads used on the galleys.

The smaller galley more than two thirds exposed by the draining of the lake. In oval: Examining the timbers of the craft. They were found to be remarkably preserved.

Discovers Some Flies Are Allies of Man

Certain flies are beneficial rather than injurious to man, according to C. H. Curran, assistant curator of insect life at the American Museum of Natural History, New York City, who has recently announced the results of his observations of the fly family.

The young of a certain species of tropical mosquito, which is numbered among the flies, he found, live almost entirely upon the young of other mosquitoes. In addition, there are also various kinds of flies that benefit man by preying upon caterpillars, beetles, and beetle larvae. One species, for example, has an ingenious method of attack. It will deposit thousands of eggs on the leaves of low plants and grasses. Caterpillars eat the leaves, swallowing the eggs. The eggs hatch and the young maggots feed upon the cutworms that swallowed them.

Field Gun's Recoil Proves More Powerful than a Ten-Ton Tractor

The terrific recoil of field guns was demonstrated recently before rookies of the Citizens' Military Training Camp at Fort Funston, near San Francisco, Calif.

A ten-ton tractor was hitched to the barrel of one of the large field-pieces by means of a steel cable. With its throttle wide open, the powerful machine attempted in vain to pull the gun back against the recoil mechanism, although the force of the explosion when fired will push it back a considerable distance.

Hitched by a steel cable to the barrel of an Army field gun, the powerful tractor was unable to pull it back against the recoil mechanism, though the explosion when the gun is fired will drive it back some distance in a split second.

Gas Tank Lock Safeguards Automobile and Fuel

A new gasoline tank lock, designed to protect motorists from unauthorized use of their machines as well as to prevent theft of gasoline, has just been invented. The lock closes the opening in the gasoline tank filler cap which lets in air to take the place of the gasoline drawn into the vacuum tank. When the lock is in place, only a small amount of fuel can be drawn from the vacuum tank into the engine.

If a joy-rider attempts to take the machine for a spin without the owner's knowledge, the car will travel only a few hundred feet before the motor stops for lack of gasoline. When a car is put in storage, the lock prevents anyone filling the tank and using the car without the owner's consent. When the key is turned, unlocking the device, air is allowed to flow into the tank without interruption. With the lock in place, petty garage thieves cannot siphon out gasoline through the filler opening.

Locking the gas tank stops the flow of fuel to the engine, guarding the car from theft.

New Giant Strawberries Run Six to the Pound

Strawberries that weigh nearly three ounces apiece are being raised by farmers near Hamburg, Germany. Called "Upper Schlesian," the enormous berries are said to be of an appetizing rosy hue and to have perfect form and delicious flavor.

Meanwhile, the Bureau of Plant Industry of the United States Department of Agriculture announces a new breed of strawberry called the "Blakemore," superior in its bright color and firmness to those now on the market. It is the result of patient cultivation in the field station near Glen Dale, Md., which has furnished more than 30,000 seedlings from the original cross made in 1923. The new variety, to be on the market about December first, is said to be suitable both as a fresh fruit and for preserving.

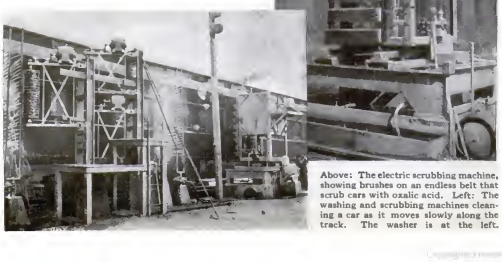
Railway Cars Washed by Electric Scrubbers

Rotating brushes almost as big as a man scrub the dirt from the "faces" of Baltimore and Ohio passenger cars at Baltimore, Md., and Pittsburgh, Pa. Using new electrically operated car washing machines, five men make 100 cars spick-and-span in an eight-hour day. Working by hand, it takes eleven men an hour to clean one car.

First the grimy car is scrubbed with a solution of oxalic acid, then a washing machine bathes the coach with water, removing both cleansing solution and dirt.

In the scrubbing device, endless belts on frames on each side of the track keep huge horizontal brushes in vertical motion. The oxalic acid solution is sprayed over the brushes by a small pump. The frame to which the brushes are fastened can be moved forward to place the brushes in contact with the sides of the car and backward when the car is cleaned.

The washing machine, located on the same track with the scrubbing device, also has frames on each side of the track. On each are mounted three vertical rotary brushes, each fitted in a swinging frame actuated by a tension spring and lever to keep the brush in contact with the irregular surface of a car. Each brush makes 300 revolutions a minute. A perforated pipe standing vertically on each side of the machine sprays water against the side of the car at a sixty-pound pressure. The cars, drawn by a locomotive, pass through the washers at a speed of from fourteen to twenty-five feet a minute.



Above: The electric scrubbing machine, showing brushes on an endless belt that scrub cars with oxalic acid. Left: The washing and scrubbing machines cleaning a car as it moves slowly along the track. The washer is at the left.

Dam Begun in Swiss Alps To Be Europe's Highest

Near the summit of the Jungfrau, in the Swiss Alps, what is to be the highest dam on the European continent is now under construction as part of a giant hydroelectric project. The structure will be 371 feet high when completed—only fifteen feet short of the great Diablo Dam (P. S. M., Oct., '29, p. 60) now being built, by the city of Seattle, on the Skagit River in the state of Washington, which, when finished in the spring, will be the highest dam in the world. The Swiss barrier, however, will be considerably larger across the base. It will be 223 feet thick, as against 150 feet for the American dam.

The electric plant of which the new dam is to be the principal portion will be the greatest in Europe, with an estimated capacity of more than one third of a million horsepower. The dam will create a lake more than three miles long, from which the water will pass through turbines and conduits for a series of falls totaling 4,000 feet, forming a generating system twelve and one-half miles long.

Building materials for the dam are carried up the mountains by a specially constructed cable railway, two thirds of a mile long and climbing at an angle of forty-six and one-half degrees.

Extra "Finger" Permits New Organ Effects

An "eleventh finger" for pipe organ playing is the invention of William Hoffman, theater organist of New York City. It consists of a rod, curved downward at the end, attached to the musician's head by means of a band which holds it firmly and gives leverage for pressing down keys and stops. The invention allows Hoffman to press down a stop to change the tone effect of the music without causing a break in the piece he is playing. In the past, it was necessary for the organist to take his hand from the keys long enough to operate the stop. Besides manipulating stops with his "eleventh finger," Hoffman says he can play a melody on either of the upper keyboards with it while using both hands for the production of variations and effects on the two lower manuals.

A California motor patrolman weighing a truck suspected of being overweight. The law specifies the maximum weight, as a too-heavy truck will pound the road to pieces.

William Hoffman (left), New York theater organist. With an "eleventh finger" of his own devising he can operate the stops without taking his hands from the keyboard.

Woman Designs "Carpet Sweeper" for Streets

Mrs. A. L. Parrott Carey driving the new motorized street-cleaning machine which she designed. Its inclosed broom sweeps a path seven feet wide.

A seven-hundred-pound broom that sweeps the pavement in a giant "carpet sweeper for streets" was recently demonstrated in New York City by Mrs. A. L. Parrott Carey, its designer. As the machine rolls through the streets, a circular broom at the rear revolves in a direction opposite to that in which the sweeper is traveling, so that dirt and rubbish are thrown on a chute and carried by a conveyor belt to a huge bin at the front of the apparatus. When the bin is full of sweepings, it is carried to a dump or incinerator and emptied.

The glorified carpet sweeper is said to clean a strip of road seven feet wide and six miles long in one hour. Because the broom is inclosed, the makers of the apparatus point out, no dust is raised by the operation of the machine, thus overcoming the chief defect of the older type of cleaner.

Portable Scales Detect Overweight Trucks

Arguments over the weight of motor trucks on restricted highways, where state laws set the maximum load, are cut short by members of the "Weight Detail" of the Los Angeles County Motor Patrol, who weigh the suspected truck on the spot. They use four miniature platform scales, one for each wheel. The readings of the four scales are added together and the sum gives the total weight of vehicle and load. Weights up to thirty tons are recorded by the four scales, each being capable of showing 15,000 pounds. The weighing equipment occupies small space and can be transported easily. It gives accurate evidence and eliminates guesswork and mistakes, the officers report. Other states recently have passed laws restricting the loads of trucks on certain highways as a means of lengthening their life.

Army Aviator Will Test Camera's Range

How far can a camera see? Capt. Albert W. Stevens, Air Corps aerial photographer, is about to find out, after receiving official approval of his experiments. He plans a flight through Montana, Washington, Oregon, and other mountainous districts, using distant ranges for camera targets. The results will be of value in improving the technique of military and high-altitude photography.

Excluding photographs of stars and other heavenly bodies, the longest range pictures ever made reveal objects at a distance of 175 miles. These were taken by the Air Corps about five years ago. Today, with improved cameras and lenses, Captain Stevens hopes to raise the camera's effective range to 200 miles or more.

Army Tank Speeds Mile a Minute

The speedy new Army tank with its inventor, J. Walter Christie. Left: The tank traveling forty-three miles an hour over rough fields in test.

A "greyhound" Army tank that charges over sand dunes and plowed fields at forty miles an hour and streaks down highways at a mile a minute, is the latest addition to the fighting strength of the United States. The speedy war machine, which carries three men, passes the ordinary tank as though the latter were standing still and gets under way before the more unwieldy machines of the past begin to move.

The spectacular new tank showed what it can do recently in tests conducted before Army officers at Camp Meade, Md. Over rough ground, its caterpillar treads carried it at 42.55 miles an hour. When the treads were removed, which operation takes but a few moments, the armored fighter, running on wheels, was clocked over a trial course at sixty miles an hour. The machine, which was designed by J. Walter Christie, an armament expert, is about two thirds the size of the average Army tank. It is intended, its inventor points out, for quick smashing surprise attacks upon enemy lines rather than for heavy combat work.

Reindeer Raising a New Canadian Industry

A herd of 3,000 reindeer has been acquired by the Canadian government in Alaska with a view to domesticating the animals in the northwestern part of the Dominion. The animals will be brought along the north coast of Alaska to 15,000 square miles of grazing grounds in the territory east of the delta of the Mackenzie River, selected for the purpose after a thorough survey.

According to a recent United States government estimate, there are now about 1,000,000 reindeer in Alaska, performing not only valuable service as beasts of burden but also forming an important source of food and clothing for the Eskimos of the Territory.

The Canadian government in 1911 made an unsuccessful attempt to domesticate reindeer. Fifty of the animals were imported from Newfoundland and taken to the northwest where, after about five years, they either died or joined herds of wild caribou.

Giant Board Shows U. S. Fleet's Movements

Separated sometimes by thousands of miles, the vessels of the United States Navy are spread out on the Atlantic and Pacific Oceans. How does the Navy Department in Washington keep track of all the ships?

A giant blackboard, so high that the upper portions have to be reached by a rolling ladder similar to those used in shoe stores, solves the problem. Tab is kept upon the far-flung ships by posting their position on the board, which is divided into four columns. One column tells the name of the war vessel, another the date its position was received, another its movement, and another when it is due at its destination. At a glance, Navy officials can tell the squadron, division, and type of ship, as well as its exact location, by means of the "battle fleet blackboard." In the photograph at the right Lieut. Commander H. E. Hintze, left, and Capt. A. P. Fairchild, director of the ship movement division of the Navy, are shown checking the positions of the battleships during recent war maneuvers.

Whereabouts of U. S. Navy ships is told at a glance by this board in the Navy Department, Washington.

Travels Million Miles to and from His Office

The amazing total of 1,046,938 miles — almost forty-two times the circumference of the earth—has been traveled by H. S. Chapman in thirty-nine years of commuting between his home at Katonah, N. Y., and New York City, a distance of only forty-two miles. He has covered sufficient mileage to have made a trip around the world each year and have enough left for an 1,800-mile "vacation" jaunt every summer.

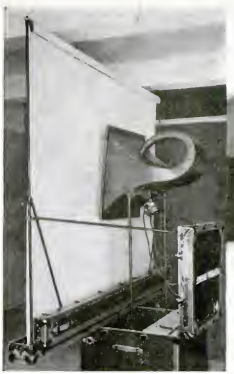
From the railroad station in New York, Chapman takes the subway to his office, and this increases his daily round trip to 92.24 miles. This he has made on an average of 291 times a year since April, 1890. But Chapman is also a champion of punctuality. In the entire thirty-nine years, he has missed his 6:40 A.M. train only twice, and has been absent from his office—not counting holidays and vacations—an average of once a year.

Mount McKinley's "Smoke" Is Wind-Blown Snow

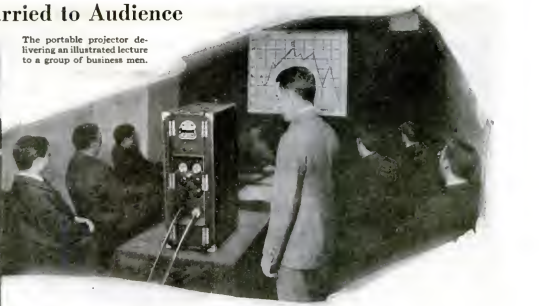
The adage that there is no smoke without fire does not hold good in the case of Mount McKinley, highest peak in North America. Many visitors to Mount McKinley National Park, in Alaska, have thought that the mountain was volcanic because of clouds of "smoke" that appeared to issue from its summit.

According to Henry P. Karstens, formerly superintendent of the Park and a member of the first party to reach the top of Mount McKinley, the "smoke," seen only in winter, consists of masses of dry, loose, crystallized snow that are hurled over the crest of the mountain by high winds. The flying drifts, estimated at times to be from twenty to fifty miles in length, assume a slate color under certain light and are easily mistaken for the "smoke screen" thrown off by a volcano.

Talking Movies Carried to Audience



The trunks in which they are carried support the horn and screen of a new "talkie" outfit.



The portable projector delivering an illustrated lecture to a group of business men.

One-night stands of talking moving picture shows are possible with a portable outfit that can be carried about the country as baggage and set up anywhere. The apparatus, designed by the Bell Telephone Laboratories, New York City, primarily for use in schools, sales rooms, and churches, can also be used in theaters seating up to 800 people. It gives the same quality of sound as the equipment used in large movie theaters.

The entire equipment, packed in four trunks, weighs only 800 pounds, and will operate on the ordinary alternating current electric light supply. The screen and horn are braced with a framework unfolded from the trunk in which the horn is packed for shipping, so that no supports to wall or ceiling are necessary. After the program is over, the screen rolls back into its compact container on a curtain roller.

In addition to presenting entertainment, such equipment should prove useful as an aid to interesting school children in historical subjects or in the study of language. Salesmen, too, might use it to demonstrate with sound effects the processes connected with the manufacture of the products they wish to sell.

Extension Scaffold Perch for Building Washers

To facilitate the job of cleansing the stone face of a building, a Chicago, Ill., inventor has designed an extension platform that can be raised or lowered easily as the work progresses. A crank at the bottom of the shaft, operating through a series of pulleys, lifts or lowers the three sections of the telescoping support to the desired position. The base of the apparatus is mounted on casters so that it can be moved from one place to another. When the platform is in use, however, the jack-like legs screw down against the sidewalk, bracing the four corners of the base rigidly and preventing the apparatus from rolling or tipping.

Washing the face of an office building, it has been shown by experiment, is an important part of preserving the finish, if it is made of polished stone. The smoke and acids contained in the air of most cities corrode the stone unless it is periodically scrubbed and rinsed.

The names and addresses of manufacturers of devices described on these pages will be supplied on request wherever possible. Write to the Information Department, POPULAR SCIENCE MONTHLY, 381 Fourth Ave., New York City, inclosing a self-addressed stamped envelope.

This telescoping scaffold eliminates climbing in and out of windows when building fronts are being washed.

Motor Boat Beats Old *Robert E. Lee* Record

Reminiscences of the days when smoke-belching side-wheelers ploughed the Mississippi in furious rivalry were evoked recently at St. Louis, Mo., when the motor boat *Bogie* drew up beside a wharf after churning her way from New Orleans, La., in eighty-seven hours and thirty-one minutes. She had smashed the fifty-nine-year-old record of the steamboat *Robert E. Lee*, established in the dramatic race with the *Natchez*, famed in song and story, by two hours and forty-three minutes.

Since 1870 no river craft had bettered the *Robert E. Lee's* time for the run from New Orleans to St. Louis, 1,154 miles by water. Dr. Louis Leroy, of Memphis, Tenn., owner and pilot of the *Bogie*, had made two previous unsuccessful attempts to establish a new record.

Silkworms Vaccinated Against Disease

Little did Edward Jenner, famous English pathologist, dream, when he discovered smallpox vaccination in 1798, that inoculation would ever be used to protect silkworms from disease. Yet this was done by Dr. Domenico Carbone, of the University of Bologna, Italy, the other day. The cultures were applied to immunize the silkworms against "yellowing" and "limpness." When afflicted with the former, the caterpillar turns yellow, dries up, and dies; when suffering from the latter, its body becomes limp and paralyzed. No remedy for these diseases has ever been found, though they are known to be caused by germs related to the molds growing on spoiled food.

In laboratory tests, vaccines were prepared for the two germs and were either sprayed over the silkworms' bodies or mixed with their food. The worms then became immune to the disease for which they were thus "vaccinated."

New Rack Lowers Music for Child Pianists

To prevent eye-strain among children who practice on grand pianos, Irving W. Giese, of Chicago, has invented a music rack extension that brings the sheet down where it can be easily seen. An enthusiastic pianist himself, Giese noted that the music rack on the ordinary grand piano is adapted for adults and not for children or near-sighted persons. The extension is hinged to the back of the regular rack and is folded back out of sight when not in use. When a child uses the instrument the regular rack is lowered and the extension folded down so that the sheet of music is on a level with the eyes.

This extension for a grand piano rack brings the music down to the level of a child player's eye.

Ship Plying to Africa to Have Refrigerated Air

Broadway breezes will invade the Mediterranean next year when a new ship of the Cosulich Line, which will ply between Italian and Egyptian ports, will be put into service. The vessel will be equipped with an air-cooling system similar to ones used in American theaters.

Mario Cosulich, engineer of the steamship company, made a special trip to New York not long ago to study the refrigeration systems in large Broadway show houses. He explained that one of the most difficult problems of the line's Egyptian service is ventilation, due to the great heat along the African shores, and said he thought theater cooling methods would prove successful at sea.

Cows Fed Legume Hay Give More Milk

By growing legume hays and feeding them to their cattle, experts of the United States Bureau of Dairy Industry point out, farmers would cut down their feed bills considerably and at the same time develop better milch cows. The legume hays, because of their high-quality protein and lime content, furnish more milk-making nutrients at cheaper cost than the other varieties. Especially in cases where cereal grains and non-legume roughages are used, additional protein often has to be bought in the form of linseed and cottonseed meal.

As early as the first century after Christ, Lucius Junius Moderatus Columella, Roman writer and author of a work on agriculture, recommended legume hays, such as alfalfa and vetch, as the best fodder for dairy cows. Since then, the truth of his contention has been proved time and again, but still only forty-one percent of the hay grown in the United States, according to Government dairy experts, is legume hay.

U. S. Has Vast Lands Still Uninhabited

While urban centers are getting more and more congested and life of apartment dwellers in large cities resembles that of bees in a hive more closely from year to year, there still are vast regions flying the American flag that are virtually unexplored and uninhabited. Geologists and topographical engineers of the United States Geological Survey have been mapping the hitherto almost unknown south central portions of Alaska. There, between the Skwentna River on the north and Lake Clark on the south, and between the west front of the Alaska Range and Cook Inlet, lies an area of thousands of square miles inhabited almost exclusively by black and grizzly bears, moose, caribou, and mountain sheep. With the exception of a narrow strip of marshy land, this part of Alaska consists of glaciated mountains.

So far, about 1,200 square miles have been surveyed, under great difficulties. The only trails the map-makers found were those made by animals, forcing them to use pack horses and boats dragged by hand through swift mountain streams. The party traveled for months without encountering a human being, and the remains of native camps they found were from twenty to thirty years old.

Holds Plane Motionless In Air for Hour

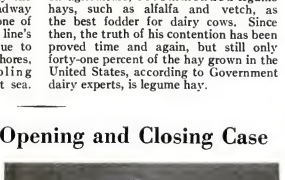
Hanging like a huge kite 3,000 feet above the Chicago Municipal Airport, a cabin monoplane, with Howard Stark, air mail pilot, at the stick, recently remained stationary for almost an hour. A mile-a-minute gale was blowing at that altitude, and by throttling down his motor, Stark kept the speed of his plane equal to that of the wind so that it hovered over one spot.

The feat recalls the so-called "suicide flight," in 1910, of the daring French airman Hubert Latham. At an air meet at Blackpool, England, Latham took up his small plane in an eighty-mile gale. The frail craft reared and plunged, carried by the force of the wind, in what early air enthusiasts still remember as the most thrilling flight they ever witnessed. Latham, who had been told by doctors that he had only a few months to live and who took up flying to get the most thrills out of his last days, landed safely.

Watch Wound by Opening and Closing Case

Opening and closing the case of this ingenious self-winding watch is said to keep it operating. If the timepiece is looked at eight times in twenty-four hours, the springs will be kept wound, the maker reports. A special feature of the mechanism prevents over-winding if the case is opened more frequently. Instead of having a case that opens upward, as in a watch with a hunting case, the two halves of the inclosure of the little timepiece move in and out in the manner of sliding doors.

No larger than an ordinary size watch, the device may be easily slipped in a pocket or hand bag. The case protects the crystal against breakage. A special stand that holds the case in an open position adapts the timepiece for use on a home or office desk or bedroom dresser.



The self-winding watch with case closed. Comparison with coins and keys shows its small size. Opening and closing case keeps the watch always wound.

Held open in stand, the watch makes a serviceable desk clock.

Shortest Air Mail Line

What is said to be the world's shortest air mail route, traversed by amphibian planes in six minutes, recently opened in Chicago. The novel line forwards mail from the municipal air field, where air mail planes alight, to the Chicago waterfront, four minutes from the post office. Mail is delivered at an estimated saving of two hours. Before the start of the "air ferry" service, motor trucks made the delivery.

Finds Mars Has Springlike Climate

Our neighbor planet Mars, basking in a temperature not unlike that of New York or Philadelphia on a sunny April day, may be inhabited by human beings. The red orb is not freezing cold, as long supposed, but enjoys a daytime heat of some sixty degrees, if Dr. W. W. Coblentz, of the United States Bureau of Standards, is correct in recent delicate measurements. His discovery is the latest and perhaps most powerful argument in favor of the long-disputed possibility of human life on Mars.

It is not probable that the splendid view of Mars due in 1939 will help settle the question. Then the planet will be "only" 35,000,000 miles away; often it approaches the earth for months at a time no nearer than 63,000,000 miles, due to its warped orbit.

But even at its nearest, it would be fantastic to expect people on Mars to be visible through a telescope. New York and London, placed on Mars, would be mere specks to the most powerful reflectors; buildings and vehicles wholly invisible. Only indirectly can we guess at the existence of people on Mars—people who, according to Doctor Coblentz's latest heat measurements, might well wear spring-weight woolens in the daytime and bundle themselves up for the snappy zero nights.

Breeds Wingless Hens to Increase Egg Yield

A strange brood of wingless and almost clawless chickens was recently produced by Dr. R. T. Renwald, of Omaha, Neb., after a series of experiments lasting five years. The chicks are members of the fifth generation, beginning with a "freak" hen that had stunted wings. Out of the sixty chicks in the present brood, some have but a stub of one joint for wings, and no toenails. One chick without even a stub of a wing was hatched, Dr. Renwald says, but died.

Besides being attractive because they cannot scratch up gardens or fly over fences, the new breed of chickens may prove valuable through increased production of eggs, the experimenter declares. Normal hens, he says, are bothered each year with the molting of their wing feathers. During this period, egg production falls off. The new hens, having no wings, he maintains, can go right on laying, possibly piling up a record of 300 eggs a year. Dr. Renwald plans to exhibit his wingless egg-layers at the World Poultry Congress in London next year, it is reported.

Powdered Coal for Ships Proves Worth in Test

Burning pulverized coal, the freighter *West Alsek*, running from New York to Glasgow, is reported to have made between nine and one half and ten knots during the entire trip, an increase in speed over her previous performances as a hand-fired coal burning vessel. In addition to the gain in speed, the *West Alsek*, in this trial run, showed a reduction in fuel consumption.

The use of pulverized coal is said to make possible a reduction in fireroom forces and to save fuel by preventing the escape of considerable heat energy through the funnels of the ship. In the system employed on the *West Alsek*, ordinary coal flows through a series of pipes to a pulverizer about six inches from the burner. Here it is ground as fine as talcum powder and forced by a blast of compressed air into the burner. The flame produced by the powdered fuel is similar to that of an oil burner.

Screws Driven Speedily with One-Hand Tool

Screws may be driven more speedily, it is said, by a novel one-hand screw driver. The tip of the handle is in line with the blade, but the end of the handle nearest the blade is offset. This arrangement gives a portion of the handle a rotary motion, thus affording much greater leverage while holding the end firmly in the groove on the screw's head, the maker explains. The tool is said to be particularly useful in loosening rusted screws and in driving home new ones.

Made 500 Parachute Jumps

Half a thousand times, Sergeant R. W. Bottriell, of the United States Army Air Corps, has dropped to earth safely by parachute. He says his score of 500 successful jumps forms a record, and he plans to confine himself in the future to ground instruction at Kelly Field, Texas. Bottriell began parachute jumping before the war, making his first leaps from hot air balloons.

Built Seaside Home to Resemble Ship

A fantastic home, designed to resemble a stranded vessel beside a lighthouse, has been constructed on the shore of the Pacific Ocean near Santa Monica, Calif., by O. J. Salisbury, wealthy resident of Pasadena. When Salisbury planned his seaside residence, he decided to make it of unusual design, appropriate to its location. A complete vessel in outward appearance, even to the presence of flags, life preservers and a bell, the strange dwelling deceives tourists, motoring along an adjacent highway, into believing it is a derelict washed up on shore by the tide. The "lighthouse" is another seaside cottage built next door to the "ship."

This novel seaside home in California looks like a ship.

Carves 200 Merry-Go-Round Horses a Year

Ponies and war chargers, Arabian steeds and Wild West mustangs, high-stepping thoroughbreds and fleet-footed race horses, all carved from wood, come from a strange workshop in Philadelphia where Frank Carretta has been carving out merry-go-round horses for thirty years. Children all over the country shout their approval of his work as they circle to the noisy strains of the calliope. His lifelike reproductions are said to be in amusement parks from coast to coast.

These wooden horses are made principally of white pine, a wood which has been found capable of standing the stress of weather and usage imposed upon them. Their size depends to some extent upon the place which they are to occupy in the merry-go-round.

How a powerful charger emerges from a block of wood under the skillful chiseling of the veteran craftsman is seen in this picture, taken in Carretta's workshop. Each year, about two hundred wooden thoroughbreds leave the workroom for their active existence at carnivals, fairs,and amusement parks.

Frank Carretta putting the finishing touches on a merry-go-round horse. He has been carving them from wood for thirty years.

Alcohol Injection Tested as New Anesthetic

Alcohol as an anesthetic, to replace chloroform and ether, promises the possibility of revolutionizing surgery, according to Dr. Miguel Garcia Marin, of Mexico, who claims the discovery of an effective method of administering it.

Dr. Marin, with the assistance of a fellow countryman, Dr. Raoul Ortiz, first tested the new anesthetic on animals. Later the two doctors went to Europe, where operations using their method are reported to have been performed successfully on human beings.

The alcohol is injected directly into the blood to bring about anesthesia. The state of anesthesia induced is more effective, the discoverers say, than that brought about by chloroform or ether, and is far less injurious to the system. Pure alcohol, the Mexican doctors point out, is less than 1/100 as poisonous to the human organism as either of the other two drugs. By the new method, they also claim, anesthesia can be prolonged, whenever necessary in serious operations, to an extent not previously possible. In operations on the head, the use of alcohol is said to be particularly valuable, for ether or chloroform, besides being disagreeable to the operating surgeon, is often dangerous to the patient.

Dr. Ortiz also has developed a device which automatically injects the alcohol into a vein at the elbow. This, he says, will enable a surgeon to work without the help of an assistant.

Buffaloes Thrive in New Alaskan Pastures

Nineteen American buffaloes liberated at Jarvis Creek, Alaska, last year have been reported well and thriving by observers. The experiment raises new hopes that the bison, once threatened with almost certain extinction, may roam the plains again in a new habitat where he will not conflict with the civilization that banished him.

At one time herds of buffalo, 100,000,000 strong in all, grazed upon the western plains of the United States and Canada, endangering the lives of pioneers when a fright sent as many as half a million of them stampeding across country. Today they have been all but wiped out.

The newcomers to Alaska were taken from the National Bison Range in Montana, one of their last outposts. Montana furnished nearly all of the original 740 buffalo which in 1908 formed the start of the present herd of more than 5,000 at the Canadian National Buffalo Park at Wainwright, Alberta.

Canada, as well as the United States, is interested in colonizing the Arctic with bison. Five thousand, from the Alberta park, have been shipped north and released to join the native wood buffalo inhabiting the territory around the Wood Buffalo Preserve at Fort Smith in the Northwest Territory.

"Paints" Picture with Scraps of Leather

A unique form of sewing "paintings" with bits of leather has been evolved by Marley H. Aken, a tailor of Richland Center, Wis. When the upholstery wore out on his favorite chair, Aken re-covered it with strips of leather and cloth, giving it a checkerboard effect. Something seemed lacking; so he cut out and sewed leather birds on the cloth squares. The result was so striking that he attempted a picture made wholly of pieces of leather.

His masterpiece, shown below, required five months to finish. It is five feet high and eight feet long, illustrating the capture of a tiger by an Oriental hunting party. To get the proper effect, Aken says, the leather has to be stretched in some places and shrunk in others.

Two hundred thousand pieces went to form one recent picture of his—an Indian visiting a settler's cabin. Every leaf of the trees and underbrush, and every bead on the Indian's buckskin clothing, is a separate piece of colored leather.

Marley H. Aken, Wisconsin tailor, dyeing one of the thousands of small pieces of leather that make up this "painting," depicting the capture of a tiger. He worked on it for five months.

Radio and Machinery Boost Modern Whaler's Catch

Moby Dick, the huge white whale in Herman Melville's sea yarn, would not be so hard to catch if Captain Ahab had commanded a ship such as the *Ernesto Tornquist*, up-to-date Argentinian whaler. Besides being equipped with modern machinery for handling her "catch," the *Ernesto Tornquist* boasts a radio station with a radius of 200 miles, permitting the ship to talk with other vessels and so facilitate her field operations.

The vessel, a 10,000-ton craft with a 3,000-horsepower engine, makes eleven knots. When a whale is brought alongside, it is pumped full of air, to support the men who stand upon it to cut it into strips. A caterpillar crane then transfers these strips to the hold. A machine on deck with a capacity of 300 to 500 barrels a day then presses out the oil. Ten large boilers on deck convert the waste into fish meal, and deck lorries transport materials about the ship.

During four months of the past season, 700 whales were captured by the *Tornquist*, and the blubber reduced by the deck machines to 40,000 barrels of oil. On one voyage alone, the ship brought back from the Antarctic 28,000 barrels of oil and 2,000 bags of fish meal.

Builds "Rug" Table Top of 538 Bits of Wood

Reproducing the pattern of an ancient oriental rug by inlaying wood in a table top is the hobby of B. A. Betendorf, a janitor in a Los Angeles, Calif., public school. Working 180 hours at odd times, he has just completed the unusual design on what he has named his "King Tut Table." Eight kinds of trees supplied the 538 pieces of wood forming the design.

The art of inlaying, as old as civilization itself, is again coming into its own as a hobby among amateur craftsmen. It was practiced first by the ancient Egyptians and Assyrians. The Metropolitan Museum in New York has an Egyptian stool, inlaid with ivory and ebony, dating from about 2,000 B.C., but there is evidence that the art was originated centuries before that. The Egyptians, Greeks, and Saracens, as well as the German craftsmen of the Middle Ages, have handed down an infinite variety of beautiful designs which cabinetmakers of today are skillfully adapting to modern needs.

In odd moments, B. A. Betendorf, a janitor, assembled 538 pieces of wood into this "King Tut" table top.

Annapolis Middies Learn to Sail the Sky, Too

Sailing the aerial ocean, as well as the ocean of water, is part of the work of the modern middies at the United States Naval Academy, Annapolis. Students of the second year at the famous institution now have aviation included in their studies. In the navigation classes, they are taught to chart their courses through the sky, in addition to mapping a line of voyage on water.

After the theoretical side of aviation and aerial navigation have been mastered, the future naval officers are taken into the air for practical training. Huge twin-motored flying boats, carrying aloft half a dozen middies at a time, give them their first taste of the air, as they circle over the bays and streams near the academy. Later, longer flights give the rookies a chance to put their navigation knowledge into practice. In advanced classes, the future naval officers are given instruction in "blind" flying; that is, using the plane's instruments alone as navigating aids.

Midshipmen of U. S. Naval Academy getting their first taste of flying in a twin-motored seaplane. Top: Students mapping out a course.

Nine Out of Ten Get the Measles, Report Shows

Nine out of ten of the population of the United States have had measles, and about three fourths have had whooping-cough, according to a report recently published by the United States Public Health Service. Mumps and chicken pox, with considerably reduced figures, come next in the report.

"In every instance," the report says, "the maximum fatality occurs under one year of age. The fatality of measles, whooping cough, and mumps declines to an almost negligible percentage by five years of age, but the decline of scarlet fever and particularly diphtheria is by no means as great as in the case of the other three diseases."

Power Plant's Waste Heat Used for a Garden

Cucumbers are the unusual by-product of a power plant supplying most of Berlin's electric current. When the directors of the municipal electric station at Klingenberg, Germany, sought a way of utilizing the waste heat from their turbines, they hit upon the idea of using it to warm greenhouses. The result was that while the turbines were generating power to light Berlin, 2,500 cucumber plants in a dozen hothouses produced a yield of 100,000 cucumbers at a time when all others had to be imported from warmer countries.

Now tomatoes, as well as cucumbers, have been added to the Klingenberg plant's production. Other cities are reported to be watching the experiments with interest.

Wheel Runs for 115 Years

An old-fashioned wooden water wheel that far outlived its builders quit working recently at Greenville, Ont., Canada. Workmen repairing its axle, which had collapsed, discovered that the wheel had been running for 115 years. During this period of service the one-ton wheel furnished power for a paper mill.

Former Champion Auto Racer Now Garage Man

Customers who drive up to a combination garage, repair shop, and filling station in Chicago, Ill., have their cars attended to by a famous racing driver. "Cliff" Woodbury, National Dirt Track Champion in 1927, recently deserted the excitement of the roaring road for the more quiet and less dangerous life of a garage owner.

Woodbury, a motor expert, is his own mechanic, repairing ailing machines with the same sure hands that once held the wheel of a racing car as it spurted 150 miles around the track to a new world's record, averaging more than 130 miles an hour for the distance. The retired champion is seen in the photograph above pumping gasoline into the tank of a car in front of his garage.

Measures Energy Used in Piano Playing

When Paderewski plays one of Liszt's Hungarian Rhapsodies, how much energy does he expend at the keyboard?

Questions such as these may be answered with the aid of an ingenious piece of machinery invented by Dr. Kurt Johnen, a German pianist whose hobby is engineering. The device records in graphic curves the energy used by the player, the contraction and expansion of his muscles, and the rhythm of his breathing. Chest expansion and movements of the arm muscles are measured with a pneumatic girdle and cuffs, while the rate of breathing and the force of the hands' touch upon the keys are recorded through rubber hose. An intricate mechanism automatically indicates the various measurements on a recording drum.

The inventor declares that his machine will prove a valuable aid to teachers of the piano. It will enable them to record their own muscular power and respiratory rhythm while playing a certain composition, and they may then tell their pupils with almost mathematical accuracy how much energy to use and how to breathe while practicing the same piece.

Dr. Kurt Johnen, German pianist-inventor, measuring energy needed to play piano. Rate of breathing is also determined.

Dry-Cleaned Clothes Hold Color, Tests Show

Do dyes run or fade when clothes are dry-cleaned? This was the question experts of the United States Bureau of Standards recently set out to answer when they found that little or no information on the subject existed.

To test the effect of dry-cleaning, they obtained samples of cloth from dye manufacturers colored with nearly four hundred different kinds of dyes. These included all hues of "direct" colors commonly used in dyeing cotton, silk, and rayon; "acid" colors used for wool; the brilliant "basic" colors used principally for rayon and silk; the dingier "sulphur" colors used to produce fast blacks, blues, and browns on cotton; and other types known to dyers, such as "vat" colors used widely in printed fabrics. Samples of cloth, each dyed with one of these, were placed in quart size bottles containing solutions similar to those used by dry-cleaners and shaken in a specially built machine operated by an electric motor for forty-five minutes. Then the samples were rinsed, dried, and examined for loss or change of color.

Most dyes likely to be encountered in dry-cleaning are unaffected by the solvents used, the tests showed. Three fourths of the dyes of the "direct" class were unharmed. Dyeings on wool with "acid" and other types of colors also survived the tests, as did the vat colors. The "basic" colors did not fare so well, however; and practically all of the "fast" colors of the "sulphur" type suffered slight alterations in shade.

Hose Reel Container Also Coal Chute Door

Container for hose reel in summer and entrance to coal chute in winter is the combination device suggested by Dwight Mills, ten-year-old boy of Dayton, Ohio, to his father, who carried out his suggestion and built one in the foundation of their home. When the reel is in use, the door of the container opens down on the ground and the reel, operating on ball-bearings, turns as the hose is pulled out. After use, the hose is reeled back in place and the door is lifted shut, keeping out sun and rain. In winter, when there is no need for watering lawns, the reel is removed and the opening utilized as an entrance for a coal chute.

Ten-year-old Dwight Mills with the combination hose reel container and coal chute door that he invented.

Waxed Planes Go Faster, Experiments Indicate

A coat of wax helps an airplane to slip through the air. That is the unusual claim of a manufacturer of wood finishes, following tests conducted at the Daniel Guggenheim School of Aeronautics of New York University.

In these experiments, similar panels of three-ply board, one quarter of an inch thick and all lacquered, were placed in pairs in a wind tunnel, where they were subjected to an endwise blast of air. One of each pair had been given a supplementary coating of wax. The waxed plates showed a lighter drag on wires retaining them than unwaxed plates, indicating that a plane with a wax coating gains in speed through decreased friction with the air.

A coating of wax also improves the appearance, preserves the finish, and makes the adherence of dirt more difficult.

Stock Prices Posted on Liners in Mid-Ocean

Radio operator aboard the *Leviathan* receiving New York Stock Exchange quotations from short-wave shore station. He then relays them to the lounge, where they are posted.

Below: Posting stock prices in the lounge of the *Leviathan*. Securities are bought and sold aboard ship in a branch office of a Wall Street broker.

Watching the antics of the bulls and bears on a quotation board has supplemented shuffleboard and deck-tennis as a pastime among passengers on the steamship *Leviathan*, of the United States Lines, since a full-fledged sea-going stock exchange service was installed aboard the giant liner.

With a special short-wave receiver, covering a range of from fifteen to one hundred and twenty meters, the ship's radio operators receive quotations from the New York Stock Exchange, transmitted to the vessel by shore stations at Chatham, Mass. and at Rocky Point, Long Island. As the quotations are received they are relayed to one of the lounges of the liner, where an operator chalks them on a board.

Immediately following installation of the service on the *Leviathan*, a Wall Street brokerage firm established a branch office aboard the liner, so that stock transactions may now be made for the first time in mid-ocean. Other steamships with similar offices are the *Berengaria* and the *Ile de France*.

Matches and Cigarettes Made "Fireproof"

Self-extinguishing cigarettes and matches are now a possibility as a result of six months' tests by the United States Bureau of Standards at Washington, D. C. The fire-preventing material in each case consists of a coating of water glass—air-excluding sodium silicate—which is applied over a portion of the cigarette or match so as to extinguish the fire after either has been discarded.

After determining that it takes about five seconds to light a cigarette and about ten seconds for a cigar or pipe, the investigators tested some two thousand matches and developed a fireproof match coated with water glass to within one-half inch of its head.

Similar tests on nine popular brands of cigarettes produced a self-extinguishing one made "safe" by a cork tip, one inch long, lined with water glass. The length of the water glass was determined after an examination of discarded cigarette stubs collected from corridors, city streets, and highways. Most cigarette smokers toss away a stub between one and one and one half inches long.

Pick Site for Gibraltar Tunnel to Africa

Travel by automobile directly from London, England, to Capetown, South Africa, will become a possibility if, in addition to the proposed tunnel under the English Channel, a tunnel under the Straits of Gibraltar, connecting Spain with the north of Africa, now planned by the Spanish government, becomes a reality.

A committee of engineers, recently appointed to select the most suitable spot for making tunnel soundings on the Spanish coast, has recommended a location about four miles from Tarifa, province of Cadiz, as the most suitable.

Evergreen Treetops Bend Toward Sun and Wind

In much the same manner as sunflowers, the slender, topmost shoots of rapidly-growing evergreen trees are said by forestry experts to follow the course of the sun from east to west across the sky on bright days. When it is sunless and windy, the shoots bend into the wind; on cloudy, still days they stand erect.

Uneven tension in the stems is given as the explanation of this phenomenon. On the side exposed to the sun or wind where evaporation is greatest, the tender tissues lose a disproportionate amount of water and consequently shrink. On the opposite side of the stem, the cells are swollen with water rising from the tree's roots. Thus, the shoot is pulled toward the contracting, dryer side and points into the wind or toward the sun. When the bark of the shoot thickens, evaporation is slowed down, and the strange twisting of the living compass stops. The hemlocks and pines, and other evergreens of rapid growth, display this oddity more often than slow-growing species with stout heavy top-stems, such as the spruces.

Builds a Clock Inside Small-Necked Flask

As a pastime, while recovering from an illness, a New York railroad man recently built a clock of unique design inside a narrow-necked flask. Three months of painstaking work were required to fashion the curious timepiece.

The builder selected a two-quart chemical flask six inches wide, with a one and one-eighth-inch neck, for his modern version of the hourglass. After first making the assembling tools himself, he divided the mechanism and the face of the timepiece into segments small enough to be passed through the neck of the bottle. Then, with the aid of his ingenious homemade instruments, he lowered these parts through the narrow neck and fastened them together inside the flask, mainly with screws.

The clock, which keeps fairly good time, is wound by a long key, which can be inserted at the top when the stopper is removed from the flask. As may be seen in the photograph the face of the timepiece is in the form of a ship's helm, the hour numbers having been placed around the circumference of the wheel.

Clock with ship's wheel face built with homemade tools on inside of narrow-necked bottle.

Spider Victor in Strange War with Snails

Discovery of a state of war between snails and spiders has been made by the eminent French zoologist, Professor Maurice Manquat. The war takes the form of combats between individuals, the snail pushing with its shell, the spider pouncing with all feet and weaving a net about its enemy. The spider, Prof. Manquat has found, is almost always the victor.

The basis of the war is economic. In the sunny part of Switzerland where the zoologist made his investigation the country is thickly populated with spiders and snails. The spiders spin their webs from wall to ivy creeper, or from leaf to leaf; the snails eat the leaves lazily, clinging to perilous inclines by the gum they secrete.

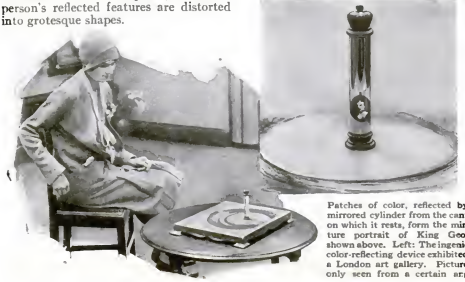
The snail, lumbering along, crashes through the fine mesh the spider has woven with infinite pains, in this way menacing the source of the latter's food. The spider at once pounces on the intruder, and soon the snail is enveloped in the fine strands of gossamer.

If the snail breaks loose the spider spins another web about it. According to Professor Manquat, the object of the spider's spinning is to tie the snail down so that it cannot move. The actual result is to make the snail so uncomfortable that it moves on to newer pasture. In some instances the spiders were successful in worrying the snails into fatal falls off the leaves to the ground.

Reflected Daubs of Paint Form Miniature Portrait

A unique miniature portrait of King George of England, called an "anamorphosis," formed by the reflections of a series of apparently unrelated daubs of paint, was on display recently in a London art gallery.

The exhibit consists of a mirror-surfaced cylinder set upright in the center of a small painted canvas. The colors forming the painting are so distributed on the canvas that, when reflected on the cylinder's convex surface at a certain angle, they form a lifelike image of the subject. This is the same theory, only in reverse, that underlies the curious effects of convex and concave mirrors installed in amusement parks, in which a person's reflected features are distorted into grotesque shapes.



Patches of color, reflected by a mirrored cylinder from the canvas on which it rests, form the miniature portrait of King George shown above. Left: The ingenious color-reflecting device exhibited in a London art gallery. Picture is only seen from a certain angle.

A twelve-ton Army tank loaded on new motor truck.

Motor Truck Carries Twelve-Ton Army Tank

A special tank-carrying truck designed for the United States Army can transport a twelve-ton tank. The tank climbs a ramp into the motor vehicle under its own power. The ramp then is lifted and locked in place as an end gate, preventing the tank from rolling off. The truck weighs eight and one half tons and has six wheels. Over good roads, it can travel nearly thirty-five miles an hour.

Telephone to Firemen Atop 90-Foot Ladder

A ladder so high that a telephone has to be used to talk to men at the top sounds like a modern version of "Jack and the Beanstalk." Yet, a ladder so equipped is part of a new fire-fighting apparatus recently constructed for the Leicester, England, fire department that proved successful in tests.

The top of a ninety-foot extension ladder is connected with the ground by a telephone wire, so that the fire chiefs can issue instructions to men combating the flames high above. Previously it had been found that in the noise and turmoil of a big fire, orders shouted to the men were heard with difficulty. The new arrangement is expected to prove a valuable aid in cases where the saving of property and lives depends upon quick action.

Officer of Leicester, England, fire department telephoning orders to fireman on ninety-foot ladder.

Curious "Camel" Plants

Mosses and ferns that might be called the "teetotalers" of the vegetable kingdom were recently discovered in semiarid parts of the Pacific Northwest by Dr. F. L. Pickett, botanist of the Washington State College at Pullman. The plants thrive in soil with only one tenth of one percent water content. The minimum moisture content required by most plants is four or five percent.

Some of the plants, kept alive between pages of a book for seven years, began to grow when water was applied. Dr. Pickett also found a wild onion which, by means of a corky outside layer, preserves its water supply for a dry season.

Audio Amplifiers Near the Ideal

Swift Improvements in Design Have Resulted in Great Power with Faithful Reproduction

By ALFRED P. LANE

AUDIO amplification is the "muscle" of radio reception. The audio amplifier in the receiver takes the extremely weak signal fed to it by the detector tube and, hy strong-arm methods, builds it up to a level that represents considerable electric power. The signal as it comes from the detector tube may be equivalent in power to a fly walking across the table. When it leaves the audio amplifier, such a signal is likely to be as strong as a small electric fan or sewing machine motor, depending, of course, on the size of the amplifier and the service for which it is designed.

Vast improvements have been made in the design of audio amplifiers in the last few years, and these advances, plus equally great improvements in loudspeakers, have resulted in the true and faithful reproduction of speech and music now obtainable from radio receivers. Three years ago it was a problem to find, among all the radio receivers on the market, a few that would give reasonably good reproduction. This year all radio sets are excellent when judged from the standpoint of tone quality. There still are differences, but the selection now is between superlatively good reproduction and merely good reproduction, instead of the choice between only fair and very poor, as has been the case in the past.

AS IN the radio-frequency and detector stages of a receiver, the tube is the heart of the audio amplifier circuit. This is particularly true of the last, or power stage. Without the power tubes now available, high grade loudspeaker reproduction with plenty of volume and fine tone quality would be impossible.

Each stage of audio amplification must consist of a vacuum tube, with whatever accessories are required to keep it working, and some means of coupling the output of the tube to the next stage of audio amplification. Resistances, impedances, and audio transformers have been used in the past to couple the stages of audio-frequency amplification. Resistance and impedance coupling methods were in great favor at one time because either method passed the signal from one stage to the next without introducing distortion. The audio transformers of those days gave strange performances ranging from the dropping of all the low notes, to distortion so severe that music or speech became a grotesque caricature of the real thing.

Audio transformers, however, make possible a greater amplification per stage than can be obtained with either resistance or impedance coupling. This is because the natural amplification of the tube is further increased by the voltage step-up in the transformer. And now that transformers have been improved until they work well at all audible frequencies, the other methods of amplification have dropped out.

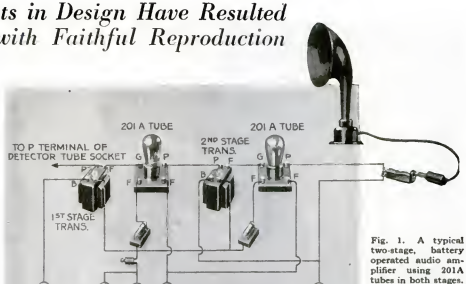


Fig. 1. A typical two-stage, battery operated audio amplifier using 201A tubes in both stages. This once standard audio amplifier circuit is obsolete now.

The voice or music signal, in the form of equivalent electrical vibrations, is passed hy the detector tube circuit through the primary of the first audio transformer. The amplified voltage resulting in the secondary winding of the transformer is applied to the grid of the first audio amplifier tube. As the flow of current through the tube is controlled by the voltage impressed on the grid, the instantaneous changes in the grid voltage result in corresponding changes in the flow of the plate current.

THE voice current flowing through the primary winding of an audio transformer produces in the secondary what actually amounts to an alternating current, so that the grid of the tube is alternately affected by positive and then hy negative voltage. The grid of the audio amplifier tube, however, is steadily maintained at a definite negative voltage.

So long as the voltage impressed by the transformer winding is not so great as to make the grid actually positive, on one side of the cycle, the action of the tube is in proportion to the voltage impressed on it. If the impressed signal voltage is greater than the C hias voltage, the grid will go positive and severe distortion will result.

Therein lies one of the secrets of the power tuhe. It is so designed that it requires a relatively high C voltage and it will, in consequence, handle without distortion a much more powerful signal than will an ordinary tuhe.

The diagrams on these pages show how the audio amplifier circuit in a radio receiver has developed since the early days of hroadcasting.

Figure 1 is a typical two-stage, battery operated audio amplifier using ordinary 201A tubes in both stages. Thousands of

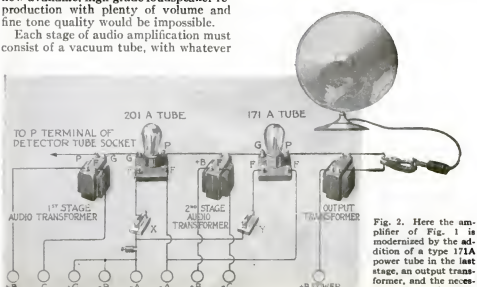


Fig. 2. Here the amplifier of Fig. 1 is modernized by the addition of a type 171A power tube in the last stage, an output transformer, and the necessary increases in the B and the C voltages.

amplifiers identical with this circuit are still operating in old and now obsolete radio receivers. Judged by modern standards this circuit is decidedly inferior. It will deliver only a small fraction of a watt of undistorted signal strength to the loudspeaker. This is about the volume required to hear the music or speech in a quiet room if the listener's ear is within a foot or two of the speaker. The minute the volume control is turned beyond this point serious distortion occurs. The lower notes, which develop the greatest voltage, swing on the grid, throwing the grid of the tube positive on every cycle. In a circuit of this type, where no C battery is used, the grids of the tubes are maintained at about one volt minus with respect to the filament by connecting the grid return wire to the negative side of the self-adjusting rheostat.

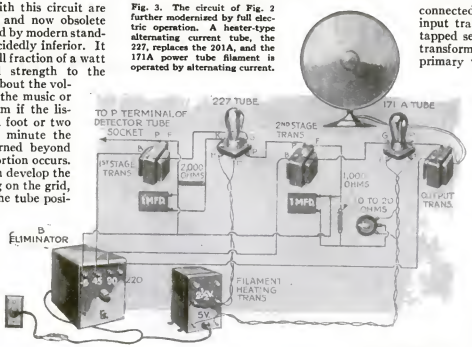


Fig. 3. The circuit of Fig. 2 further modernized by full electric operation. A heater-type alternating current tube, the 227, replaces the 201A, and the 171A power tube filament is operated by alternating current.

Figure 2 shows the same circuit modernized by the addition of a type 171A power tube in the last stage, an output transformer to protect the loudspeaker winding from the heavier plate current, and the necessary increases in B and C voltages. An amplifier of this type is about the best that can be had for battery operation if cost of operation must be kept to a reasonable figure. It will give satisfactory and distortionless amplification for quiet listening in a small room. The grid of the 171A tube is maintained at minus 40 volts with respect to the filament.

FIGURE 3 shows exactly the same circuit arranged for full electric operation. A heater-type alternating current tube, the 227, is used instead of the 201A, and the filament of the 171A power tube is operated by alternating current from a step-down transformer. The B voltages are obtained from a B eliminator. A B eliminator circuit is, without exception, an integral part of every full electric set. In commercial factory-built sets, the B eliminator circuit is built into the set, usually in metal cases at the back or at one end of the outfit.

The necessary C voltages are obtained in this circuit by taking the drop in voltage which is produced when electric current flows through a resistance. The path of the plate current of the amplifier tube, beginning at the plus B binding post on the eliminator, leads through the primary winding of the audio transformer to the plate of the tube, then across to the filament by way of the electron flow, and back to the minus B binding post of the eliminator through the biasing resistance. A high resistance voltmeter connected across this resistance will show a potential or voltage difference between the two ends of the resistance. The amount of this voltage is governed by the value of the resistance and the amount of current flowing through it.

In the circuit of Figure 3 a resistance of 2,000 ohms will develop approximately 40 volts. This voltage is subtracted, of course, from the total voltage applied to the circuit, so that if 220 volts are applied, the effective voltage on the plate of the 171A tube is 180, the maximum for which it is rated.

The resistance method of biasing is, to a large extent, self compensating. If, for example, the B eliminator circuit only develops 180 volts, the effective voltage on the plate of the tube will be less than 180 volts; but as the flow of plate current with the lower plate voltage also will be less, a correspondingly lower C bias will be developed across the biasing resistance. Such a circuit therefore tends to be self-regulating.

The potentiometer is used simply to afford a convenient means of connecting the biasing resistance to the filament circuit at a point where the alternating current voltage applied to the filament always is zero. If the biasing resistance were connected directly to either filament terminal, a portion of the filament voltage would be alternately added to and subtracted from the grid voltage, and a loud hum would result.

FIGURE 4 shows the audio amplifier circuit further modernized by addition of an extra tube in the last or power stage in the so-called "push-pull" hook-up. The filaments of the two tubes are connected in parallel and the input transformer has a center tapped secondary. The output transformer has a center tapped primary winding. The grid of one tube is connected to one end of the secondary winding of the input transformer, and the grid of the other tube is connected to the other end. The plates of the two tubes are connected at opposite ends of the primary winding of the output transformer.

The remainder of the circuit is identical with Figure 3 except that the biasing resistance has a value of 1,000 ohms instead of 2,000 ohms. There being two tubes in the circuit, the plate current will be doubled; to develop the same C voltage, the resistance is cut in half.

THEORETICALLY, two power tubes operating in a push-pull circuit will handle twice as much power as a single tube. Actually they will handle more than twice as much without perceptible distortion. A study of the method of operation of the vacuum tube will explain why this is so. The alternating current impulses applied to the grid of a tube are never perfectly reproduced in the plate current. There is a tendency toward rectification which results in partial suppression of part of either the positive or negative portion of the cycle.

In the push-pull hook up, the plate circuits of the two tubes are, in effect, connected in series through the primary winding of the output transformer. The distortion in one plate circuit is balanced out by the distortion in the opposite direction in the other plate circuit. The distortion at any instant is in opposite directions in the two tubes, because their grids are at opposite ends of the winding of the input transformer.

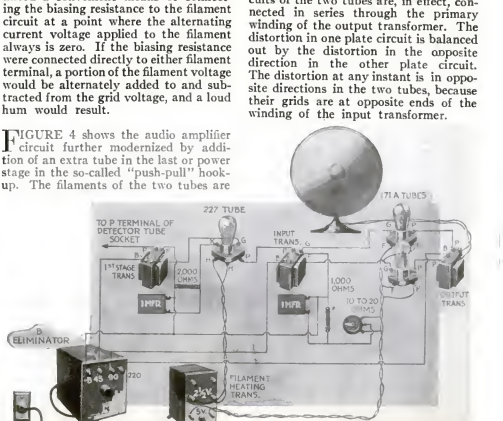
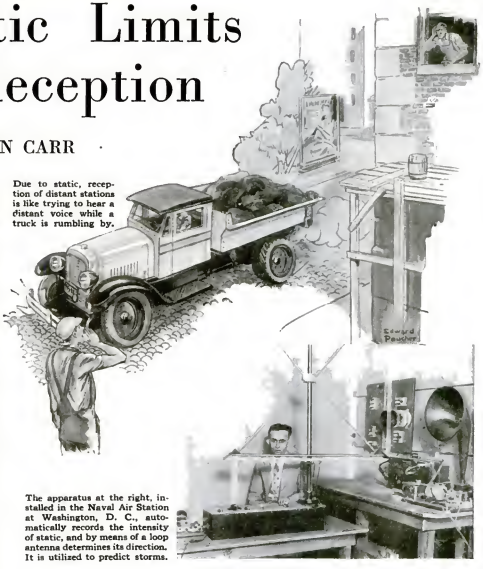


Fig. 4. Here an extra tube is added in the last or power stage, in the so-called "push-pull" hook-up.

How Static Limits Radio Reception

By JOHN CARR



Due to static, reception of distant stations is like trying to hear a distant voice while a truck is rumbling by.

The apparatus at the right, installed in the Naval Air Station at Washington, D. C., automatically records the intensity of static, and by means of a loop antenna determines its direction. It is utilized to predict storms.

A FRIEND of mine, who makes up in enthusiasm for what he lacks in technical knowledge of radio, asked me a funny question the other night.

"If two and two make four," he said, "why can't you combine two radio sets and get twice the distance?"

Now that seems to be a logical question. The only trouble is that radio reception doesn't always work according to the rule of addition, particularly in the matter of increasing power to get distant stations.

Nature has placed a limiting factor on satisfactory long distance reception. It is static. Civilization has added another called electrical interference or man-made static—produced by the operation of electrical machinery of various kinds. Natural static and the man-made variety make it impossible to go beyond a definite limit in bringing in distant stations in any given locality at any given time. The limit, of course, is not the same for any two places, nor for different times of the day or year in the same place.

And the fact that the limit is so variable accounts for most of the general misunderstanding of radio possibilities. Moreover, it creates a fertile field for the sharpers who sell worthless "static eliminators."

Natural and man-made static both are electrical phenomena. Each travels at exactly the same speed and by exactly the same method as do the broadcast waves that carry music and speech. Any conceivable type of apparatus affected by radio broadcast waves also will be affected by static or electrical interference waves.

IT IS possible to draw an accurate parallel between the action of radio waves and sound waves. Suppose a band concert were being given in a park and that a group of people desired to spoil the concert. If they assembled near the band and produced a prodigious clatter by beating tin cans, blowing foghorns, and operating other noise-making devices, the band music would be lost in a sea of noise.

A man entering the park at some distant point would hear a faint jumble of sounds. As he walked nearer and nearer to the band the jumble would grow louder and louder. But no matter how near he approached, he wouldn't be able to hear and enjoy the music.

This situation is equivalent to receiving local radio stations when the static is very bad. Most radio set owners have found that satisfactory reception under such conditions is impossible.

The reception of distant radio stations has an exact counterpart in the attempt of one man to hear another who is shouting to him from a point some distance down the road. If a roaring motor truck is passing while the second man is shouting, the first man may not hear him at all, or if he does, the words will not be clear enough to understand. Increasing the acuteness of the first man's hearing will not help matters, for it will not change the relative strength of the voice and the interfering noises. The second man can be heard only by shouting louder—equivalent, in radio broadcasting, to increasing the power of the radio transmitter.

THERE are many winter evenings in favorable localities when the air seems practically free from static, yet tests have shown that there is no locality where static or man-made interference ever is totally absent. Static always can be heard if the radio receiving equipment is sufficiently sensitive. A so-called "quiet" night always will become a noisy one if the radio-frequency amplification of the receiver is extremely powerful. For instance, a receiver such as the Screen Grid Distance Getter (P. S. M., Sept. '29, p. 70) always will record static no matter how silent the air waves may seem to be on an ordinary set.

Of course, the question of distance reception may be considered from two angles. One man may be interested in bringing in distant stations only if he can get them sufficiently free from interference to compare favorably with local reception in clarity and tone quality. Another may go after distant stations as a hobby. The latter will stand for any amount of static as long as he can understand the call letters of the station.

TO THE man who wants only entertainment from the local stations, an exceptionally sensitive receiver is of no particular advantage, unless, by chance, he is located where radio reception is normally very difficult.

On the other hand, the man who goes after distant stations as a hobby wants a set that is as sensitive as possible. On the average, with his super-sensitive set, he won't be able to get good quality broadcasting from any station not heard on the less powerful set. He will, however, be able to get down below the static level and drag in station after station as long as his ears and the family temper will stand for the terrific roar and crackle that will accompany the broadcasting.

And then, once in a while, along will come a night when static is below normal and distant station field strength is exceptionally high, and distant stations will come roaring in "just like the local station." He will experience the thrill felt by the owner of a hundred-horsepower car when he at last finds a road where he can turn the hundred horsepower into speed.

Inventions That Simplify Home Chores

Useful for spearing hot potatoes, doughnuts, or frankfurters, this ingenious fork ejects its load on a dish by means of a system of levers that slides a metal plate along the tines. It requires only one hand.

This hand-driven freezer with one-gallon capacity produces a pint of ice cream in thirty seconds. A tray receives the ice cream as fast as it is frozen.

Neat sections of grapefruit for salad making are cut with this knife. The tool, also used for cutting oranges, delivers the pieces of fruit uncrushed and without losing any of the juice.

A few drops of disinfectant placed in a special chamber of this vacuum cleaner is said to kill germs extracted from rugs being cleaned. It also purifies the air in the room and banishes stale smoke odors.

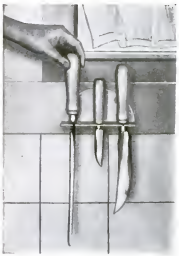
It is unnecessary to touch the hot broiling pan built into this new gas range when removing food. The pan slides out and in automatically when the oven door is opened and closed.

A new perforated cover that is clipped onto a boiling pot saves the hands from being scalded when draining water from potatoes and other vegetables. Four spring metal "fingers" hold the cover securely in place, allowing both hands to be used for lifting the pot.

A new combined kitchenette and icebox saves space in a small apartment. It can be fitted with electric stove, percolator, and toaster; and shelves and drawers hold cutlery and dishes. The ice compartment holds fifty pounds of ice.

A new rubber sponge, chemically treated, effectively cleans delicate silk lamp shades and other flimsy fabrics. The sponge, which can be washed with soap and water when soiled, also can be used to clean hats, gloves, and velvets.

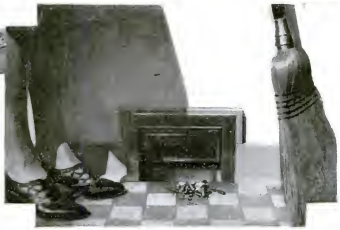
Cookies of fancy shapes are easily made with a new stamp. The batter is placed in a cylinder-shaped container and forced into shape by a die at the end of a plunger. Dies with a variety of designs are available.



A special holder that fastens to the kitchen wall keeps a set of three knives—bread, paring, and for general utility—within convenient reach.

Stepping on a pedal attached to this dustpan presses it tight against the floor, allowing every particle of dirt to be swept in.

This useful electric servant not only whips cream but polishes furniture, mixes dough, scrubs kitchen utensils, and does other household tasks with motor-driven attachments.



A compartment built into the wall at the baseboard receives floor sweepings. Its door is opened at the touch of a broom and is closed by an inconspicuous foot pedal. A dust bin inside is emptied at the housewife's leisure, or a chute to the cellar can be built. The cabinet is finished either in nickel or to match the woodwork of the room.

A bake pot used on top of the stove with one turned-low burner cooks two foods at once. The base is of cast iron, and five aluminum pans for different foods, not shown here, are provided.

An oven-fume deflector for the gas range flue collects grease, preventing unsightly blackening of kitchen walls.

During ordinary sweeping, a small brush for cleaning corners (above) rests near the top of the broom handle (shown at the left). When a tight place that the broom cannot get at needs cleaning, the attachment is slipped to the top of the handle and the broom inverted, forming a corner brush.

Making the Floor Suit the Room

The Kerseys Discover a Wide Variety of Materials and Colors to Choose from in Planning Their Home

By ROGER B. WHITMAN

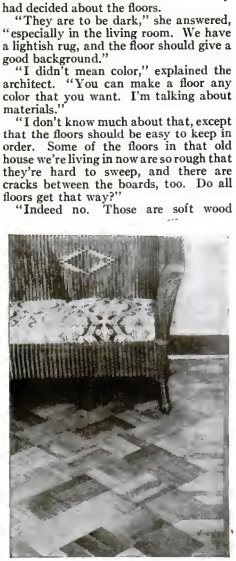
THOUGH Bob Kersey and his wife always talked things over before deciding on the materials for their new house, Bob usually had the final word on the structural parts. It was he who investigated and compared the merits of roofings, heating systems, plumbing, and similar items; but on questions of decoration and interior finish it was Mrs. Kersey who came to the front. Bob knew her good taste in such matters, and so waved to her to answer when the architect asked them what they had decided about the floors.

"They are to be dark," she answered, "especially in the living room. We have a lightish rug, and the floor should give a good background."

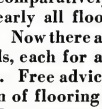
"I didn't mean color," explained the architect. "You can make a floor any color that you want. I'm talking about materials."

"I don't know much about that, except that the floors should be easy to keep in order. Some of the floors in that old house we're living in now are so rough that they're hard to sweep, and there are cracks between the boards, too. Do all floors get that way?"

"Indeed no. Those are soft wood



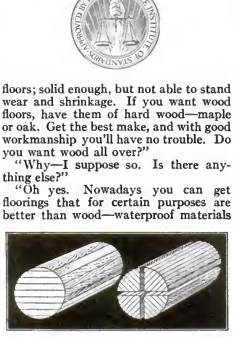
Until comparatively recent years nearly all floors were of wood. Now there are many materials, each for a special purpose. Free advice on the selection of flooring may be obtained by writing to the Building Service, Popular Science Institute, 381 Fourth Avenue, New York, N. Y.



floors; solid enough, but not able to stand wear and shrinkage. If you want wood floors, have them of hard wood—maple or oak. Get the best make, and with good workmanship you'll have no trouble. Do you want wood all over?"

"Why—I suppose so. Is there anything else?"

"Oh yes. Nowadays you can get floorings that for certain purposes are better than wood—waterproof materials

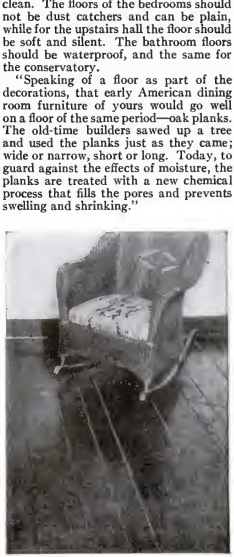


Top: How straight-sawed and quarter-sawed boards are cut from a log. Below: Prepared wood blocks to be held together by driving a loose tongue into adjoining grooves; also strip flooring, "blind nailed" to hide nailheads. Left: Block flooring, contrasted with plank flooring (right). Both are of oak, chemically treated to protect from moisture.

for wet places, and soft ones for silence or for rooms where people are working on their feet.

"THE first thing a floor should do is to stand the wear, and that'll be harder in some places than in others. For the show parts of a house—the living room, dining room, and library—you should have floors that are beautiful. In the kitchen and pantry the appearance of a floor is not so important as its feel to the feet and the ease of keeping it clean. The floors of the bedrooms should not be dust catchers and can be plain, while for the upstairs hall the floor should be soft and silent. The bathroom floors should be waterproof, and the same for the conservatory.

"Speaking of a floor as part of the decorations, that early American dining room furniture of yours would go well on a floor of the same period—oak planks. The old-time builders sawed up a tree and used the planks just as they came; wide or narrow, short or long. Today, to guard against the effects of moisture, the planks are treated with a new chemical process that fills the pores and prevents swelling and shrinking."



Bob brought up the question of floor construction. "In laying a wood floor," he asked, "is it nailed direct to the floor beams?"

"Not in good construction. A wood floor should always be double thickness—wide boards laid diagonally and covered with damp-proof paper or felt, with the finish floor on top. But a good floor should start with beams that are plenty big, and well braced. When we were down in my cellar the other day, did you notice that the beams over your head were braced with pieces of wood put in like the letter X? That's called the bridging. If it wasn't there, a jar on the floor above—dropping a trunk, for instance—would be taken by only one or two beams, and if they quivered under it the flooring nails would loosen a bit, and by and by the floor would begin to squeak. With good bridging, the beams are so solidly braced and tied together that they can't move, and instead of a jar being taken by only one or two of the beams, it is shared by all of them.

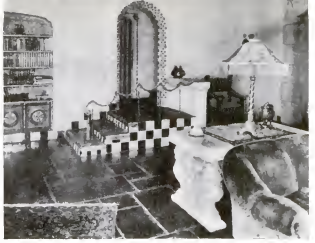
"BRIDGING is a good deal more important than most people think, for if it isn't stout and solid there'll be squeaking and general looseness. A diagonal subfloor makes things still stiffer, and a floor should be built that way for linoleum and other materials as well as for wood."

"But I thought that linoleum was nailed on, like carpet," said Bob.

"It used to be; but now it isn't considered a floor covering, but the actual floor. Its foundation is a layer of felt cemented to the subfloor and with the linoleum cemented on top. Both layers are rolled down hard before the cement dries, so that they become one piece, and with the pattern and color running clear through the linoleum it will be years before any wear shows. The same method is used for rubber, which makes a good floor, too. I saw a bathroom the other day that had a rubber floor and rubber walls. The floor was made of tiles cemented down one at a time, while the wainscot was sheet rubber of the same design; blue and tan marbleized squares. The sheets were thin enough to go around corners and jogs, so that each side of the room was a single sheet without any joints. It was cemented to the wall, and with a molded rubber base to join it tightly to the floor, it was probably about as waterproof as anything you could procure.

"People used to think that linoleum and rubber were only for kitchens and bathrooms; but now, with attractive patterns, they're being used in almost any room. In a dull tile design, you could use either one of them in your library. They're quiet, and soft to the foot."

At the suggestion of the architect, Mrs. Kersey later visited an exhibition of building materials to study samples of modern flooring. Ordinary wood flooring, she found, comes in boards up to three inches wide, or thereabouts, and up to about three fourths of an inch thick. One edge is made with a groove and the other with a tongue, and in the best makes the ends are tongued and grooved as well. The nails are driven in at an angle at the base of the tongue, so that their heads are covered by the adjoining strip. She was especially interested in oak, and saw it in several grades, some with straight grain and some with beautiful figures in the grain that an attendant spoke of as "quartered."



A typical example of the effectiveness of colored floors of processed concrete, appropriate for rooms of special design.

BUT it was not until she saw samples of parquetry that she realized the great beauty that a floor might have, for with intricate designs made of small pieces of wood of various kinds and shades, the entire floor could be a picture in itself. In the simpler designs, parquet floors are laid one piece at a time, each being nailed and glued to the subfloor, while in more elaborate work the pieces are put together at the factory on a firm base, and laid in sections three or four feet square. For her own living room, Mrs. Kersey considered that an elaborate parquet design would be out of place, and reported to her architect that evening that the pattern she liked best was in squares, made up of three widths of boards each and set at right angles to each other.

"THAT'S one of the most satisfactory designs there is," he said, "especially when the squares run down the room diagonally. And you can lay it by a new method that I've been looking into lately. The squares are made at the factory and are three or four boards wide, according to their size. The boards of each square are held together by a steel strip underneath, and the squares are grooved on all four sides. They are not nailed to the subfloor, but are held down by a thick cement that never gets quite dry and that acts as a cushion. The bottoms of the squares are dipped in the hot cement and, when set in position, are secured to the squares alongside by strips of wood driven into the grooves. I couldn't suggest anything better, especially as the wood has the same chemical treatment as the one I spoke of for your dining room. Did you see any floors made of cork?"

"Yes, and I liked them. That would be good for the upstairs hall, wouldn't it?"

"Cork floors?" Bob put in. "What do you mean, cork in sheets?"

"No, in thin blocks. The cork is ground up and then compressed. There's a lot of gum in cork, you know, and in the process it is softened enough to bind the cork grains tightly together."

"But cork is so soft that I should think it would wear out," said Bob.

"No, it's too tough. Compressed cork will last almost indefinitely. But about the bedrooms. (*Continued on page 160*)

A linoleum floor suitable for a sun porch. Above: An unusual floor made of common brick and unglazed tile rubbed down and waxed to a fine finish.

Useful Hints for the Radio Fan

Judging a Loudspeaker's Voice

How to Make B Batteries Give Longer Service—Checking the C Battery—Causes of Lag in Heater Type A.C. Tubes

A B C's of Radio

THE beginner in radio may be confused by the fact that radio circuits seem to violate a fundamental rule of electricity—that electricity always flows in a circle. In radio diagrams, he finds current flowing through wires that appear to lead nowhere.

The fact is, however, that a circuit in a radio receiver, like any other electrical circuit, must form a complete circle. The antenna circuit, for example, is a circle consisting of the antenna coil in the receiver, the ground wire, the antenna wire, and the electrical capacity between the ground and the antenna. In the grid circuit, the closed circle is the tuning coil and the tuning condenser which is connected across it. The plate circuit is made up of the B eliminator or batteries, the primary of the transformer, the electron flow in the tube, and the return by way of the filament or cathode wiring back to the B eliminator.

JUDGING the accuracy of musical reproduction from a radio loudspeaker by ear alone is exceedingly difficult even for the trained musician. In fact the musician is just as likely to make mistakes as is the music lover who has had no musical training.

The mere fact that the music sounds pleasing to the ear is no proof that the speaker is faithfully putting on the air every tone frequency fed into it by the radio receiver. A jazz band, for example, which is actually producing harsh, strident tones in the broadcast studio may be toned down by receiver and loudspeaker into an approximation of pleasant music. But that is not faithful reproduction, and if applied to better music, the toning down process may be quite unpleasant.

The human voice affords a much harder test of a loudspeaker than does music—probably because the human ear is trained to know when the human voice sounds natural. Listen to the announcer. If the voice is resonant without being hollow or throaty, and the sibilants come through clearly, the reproduction is excellent. The words "Popular Science Monthly," for example, should not sound like "Popular—eye-en—Mon—ly." Do

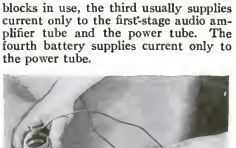
Five-prong heater type A. C. tubes such as this are the ones that cause delay going into action.

not be satisfied with mere traces of the "S" and "Th" sounds. They should be heard almost as clearly as in normal speech.

After hearing the human voice, listen to a musical selection containing drums and make sure that the drums retain their full, resonant boom.

Balancing B Battery Load

A SET of 45-volt B batteries, connected in series to supply B current to a radio receiver, do not all give out at approximately the same time. This is because the same amount of current is not drawn from each battery. The one connected to the minus B binding post of the receiver, for example, carries the maximum load. It supplies B current to every tube in the set including the detector tube. The battery next to it supplies current to all tubes in the receiver except the detector. If there are four 45-volt blocks in use, the third usually supplies current only to the first-stage audio amplifier tube and the power tube. The fourth battery supplies current only to the power tube.



Testing a C battery with a voltmeter—the best way to tell whether it has become exhausted.

In order to equalize the load on the batteries so that the maximum service can be obtained before a new set is required, it is desirable at regular intervals to shift the order in which the batteries are connected. At least once a month, move the battery at the positive end to the negative end—of course reconnecting the wires supplying the various B voltages to the receiver.

Test the C Battery

PRACTICALLY no current is drawn from the C battery; nevertheless internal leakage and corrosion eventually will end the life of the battery and the voltage will drop off. Dry cell batteries used to supply B current to a radio receiver indicate their condition in unmistakable terms. As they become exhausted the volume decreases and reception becomes noisy. When C batteries become exhausted there is no similar indication. The set performs as usual. There is, however, a great increase in the amount of B current drawn. In the case of the 171A power tube the increase is so great that the B batteries are rapidly exhausted and the life of the tube itself is materially shortened.

Replace all C batteries at least once each year unless a voltmeter reading indicates that they are still delivering the proper voltage.

A. C. Tubes Act Slowly

WITH a battery-operated set, throwing the switch that turns on the current results in immediate action. If the set is tuned to a station, music or speech issues from the loudspeaker in a fraction of a second. This is not true of modern sets operated by alternating current. There is a lapse of anywhere from ten to thirty seconds between the throwing of the switch and the first sound from the loudspeaker. The delay is caused by the slow heating of the relatively thick cathode element in tubes such as the type 227 and 224.

Many attempts have been made to decrease the time lag, but an improvement in this direction is worth while only if it can be accomplished without affecting the efficiency of the tube and the length of its life.

In any event, decreasing the time lag below the present figure is of relatively little importance. Most people will not object to waiting a fraction of a minute for the start of a period of musical or other entertainment to which they may listen for several hours.

Captain McCann, who is an authority on ship model building, fitting the upper rail on his model *Bluenose*.

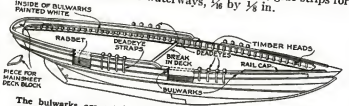
midship lines at their right positions. away with long smooth cuts, starting amidships and bringing down together and not by cut- each mark and then shaving

stern is the most difficult otted line shows where the starts; from e aft, the hull is o and of the same ckness as the keel, th is 3/16 in. The half breadth o is the counter; nearly flat across. spokeshave is the liest tool for shav- lown the hull, and vex one, or a half-round rasp or file e found useful at the stern. Leave gh for sandpapering, but do not do nal smoothing until you are ready to .

fore putting on the sternpost, bore a hole for the rudderpost as shown. cut a keel as shown from a piece of od 3/8 in. thick and nail and glue it Cut another piece for the stem nto this. Cut it a bit thicker than

required; then, after it is fastened on, sandpaper it to the required fore and aft thickness. The sternpost, which is the same thickness as the keel, can now be put in place, and the rudder made and fitted.

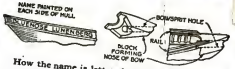
After plank-marking the deck, make the rails (bulwarks) from two strips of wood 3/4 in. wide and not more than 1/16 in. thick. Cut a rabbet in each side of the hull as shown, making it a shade less deep than the thickness of the rail. Cut the lower edge of the strip to fit into this. Then glue and nail the rails in position, shave the top to the required height, and sandpaper flush with the hull. At the stern these pieces will have to be steamed to bend them round, or they may be finished off at the quarters so that a piece may be jigsawed from the solid to fit in, as indicated in one of the detail drawings. If this is done, cut a piece on the slant to fit the inside curve, glue it on, and shave down the outside when in position. Along the inside corner of these rails, glue strips for the waterways, 1/16 by 1/8 in.



The bulwarks are set in a rabbet. Note the waterways with the timberheads over them. The top rail aft rests on the main rail cap.

Timberheads, cut 1/16 in. square, are glued to the inside of the rail at 3/16-in. intervals. On these and the rail itself lies the rail cap, 3/16 in. wide by 1/16 in. thick. For this and other small nailings, 1/8-in. bank pins are excellent, but holes should be drilled for starting them.

The upper rail for the after part can be made T-shaped with the cap in one piece, as shown. In the stern there is a new-moon-shaped piece, level with the main



How the name is lettered on each side at the stern and how the nose is shaped and bored.

The curved rail cap that fits on the stern.

T-shaped upper rail fastened on main rail.

rail cap and fastened on the hull itself.

Forward there are two strips fastened on the rail cap 1/16 in. square by 3 1/4 in. long; they start 3/8 in. from the bow and can be seen on the side elevation.

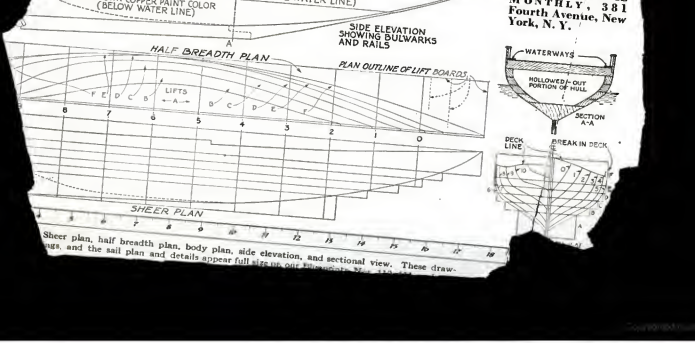
An extremely thin 1/8 in. wide covering board may be laid across the deck at the break and slightly projecting over it, to give a finish.

Give the hull a final sandpapering and two coats of flat white paint. Then paint it to the water line a red-brown copper color, and black from there up, with the exception of a narrow white line above the water line and along the main deck line.

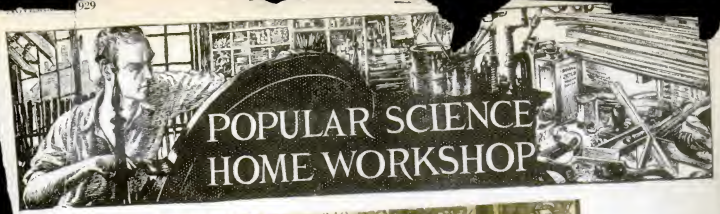
Paint the inside and top of the rails white. The lower portion and the timberheads can be painted more easily before the cap is put on. Rub down after each coat to an egg-shell gloss. Give the deck a coat of varnish, but be sure it is not shiny.

Next month we shall describe the ma ing of the deck furnishings.

For those who wish a brief history o the *Bluenose* and of the races leading up to the one in which she captured the international speed trophy, Captain McCann has prepared an interesting supplementary bulletin. This can be obtained by sending a self-addressed and stamped envelope with a request for Home Workshop Bulletin No. 2 to POPULAR SCIENCE MONTHLY, 381 Fourth Avenue, New York, N. Y.



Sheer plan, half breadth plan, body plan, side elevation, and sectional view. These drawings, and the sail plan and details appear full size on our



SCALE model of the most grace... afloat, the... schooner *Bluen*... holds the in... trophy for ... fishing schoon...

Fishing Schooner Model—*Bluenose*

By E. ARMITAGE McCANN, *Master Mariner*
Secretary *of the* Ship Model Makers' Club

FOR those who what to take up the hobby of ship model making, this reproduction of the famous fishing schooner *Bluenose* presents a splendid starting point, because the rigging is much simpler than that of a full-rigged ship, though she is as graceful a craft as ever sailed.

The experienced model maker, too, is always fascinated by the shapely fore-and-after, although he is apt to feel that a trading schooner is a bit too homely for model reproduction and that an ordinary yacht is too trivial. For him the *Bluenose* should be ideal. Aloft and alow, she is as beautiful as any fore-and-after ever was, and speedy enough to win an international racing cup. At the same time, she is essentially a working craft, built for hard usage.

The original *Bluenose*, constructed by W. J. Roue of Halifax, in 1921, is still afloat. This model is an exact reproduction of the original, reduced to a scale where ⅛ in. equals 1 ft.

What will help the model maker more than anything else to construct the model easily and accurately are the full size drawings contained in POPULAR SCIENCE MONTHLY Blueprints Nos. 110, 111, and ... These ... be sent to any reader for ... (see page 114).

...es two pieces of white ... in. by 4 ft. 8 in., and ... by 2 ft. 5 in., as well as a few pieces of hardwood. It is made of six lifts or layers. The four center lifts are ¼ in. thick, the lower lift is ¾ in. thick aft, and the upper lift the same thickness forward.

First draw a center line right around each piece, then mark the outline according to the plan view, and finally add the cross construction lines *0* to *10*. Saw away the waste wood to within not less than 1/16 in. of the outlines. Cut the centers out of lifts *B*, *C*, *D*, *E*, leaving a shell about ¾ in. thick.

Extend the cross and fore-and-aft guide lines over the edges and glue the whole together with these lines corresponding. This is most easily done by lightly nailing the lifts together as ... build up the hull. ... a nail set to drive ... heads in and l... that the points ... where they will ... trude later when ... are shaving the sid... shape.

When the glue h... cut the top lift do... the deck line, n... it 3/16 in. higher i... middle amidsh... Note the step bet... lines *4* and *5*. ... away the bottom ... hull so that it ... in. from line *9* ... to a point mid... tween lines *4* ...

On stiff ... mark the ... stern profi... *5* to *b*... an...

...wa... U... plate...

the hull until they fit ex...

Now make other ten... body plan, marking th... the keel, and the wa... With dividers, mark ... width of the deck, ... Draw a smooth c... points and shave ... almost to them.

Shave away the ... the lifts at the si... fit on, being ca... held at their co... lines and at a rig... of the hull, with ... junction of *D* ... marked with ...

Gus gave the bully, off balance, a push, and he landed with a thud that took all the fight out of him.

Dangers in Driving with Bad Eyes

By MARTIN BUNN

"JOE," growled Gus Wilson to his partner, Joe Clark, as the two clattered down the road in their old service car, "I'm about fed up on this auto business. For two pins I'd sell you my share in the Model Garage!"

"G'wan!" Joe scoffed, grinning. "You're fed up on 'hot dogs'—not autos. I told you three was too many."

"Maybe so," Gus agreed. "I do feel as though they're snapping at each other." The veteran automobile mechanic relapsed into a gloomy silence as the car sloshed on through the rain. They were rounding a curve, when the headlights revealed two cars jammed together at the side of the road.

"Speaking of fights," Joe whispered as Gus stopped the car, "looks like we're going to see one right now!"

The owner of one of the cars, a big, red-faced chap, appeared to be on the point of hitting the under-sized bespectacled driver of the other car.

"Of course it's your fault!" the big fellow yelled angrily. "Anybody that wears glasses as thick as yours must be half blind anyway. It's a good thing you've got 'em on or I'd sock you into the middle of next week. I've a good mind to do it anyhow!"

"What's the idea of picking on the little guy, you big stiff?" snapped Gus grimly as he stepped up to the speaker, who was almost a head taller than himself. "I'll bet you're to blame, at that."

"Say! Who asked you to butt in?" grated the big fellow. "Somebody's going to get a clout for this and it might just as well be you!"

With that, he aimed a furious swing at Gus's jaw. The veteran ducked and the force of the swing threw the bully off his balance. Gus gave him a gentle push and he landed on the ground with a jarring thud that took all the fight out of him.

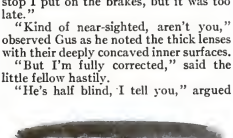
"Now let's get the straight of this," said Gus, turning to the little chap. "How did it happen?"

"I was coming down Mapes Avenue," he explained, nervously dabbing raindrops from the thick lenses of his spectacles, "and this man was approaching the crossing on my left, so I had the right of way. When I saw he wasn't going to stop I put on the brakes, but it was too late."

"Kind of near-sighted, aren't you," observed Gus as he noted the thick lenses with their deeply concaved inner surfaces.

"But I'm fully corrected," said the little fellow hastily.

"He's half blind, I tell you," argued



To a driver with "tunnel vision," only objects that are directly in front are clearly visible.

Ask Gus—He Knows

A MAN learning to drive a car goes through four stages. First there's the nervous stage, when he has to think which foot to move when he wants to put on the brake. Then comes the self-confident stage. He's mastered the mechanics of driving but he's still careful. It isn't long before he gets into the over-confident stage. He thinks he's hot stuff when it comes to handling a car. He isn't happy unless he's showing how fast he can get away in traffic, busting the speed laws, cutting in front of the other fellow, or doing some other fool stunt. By and by, if he survives the smashes, he gets to the stage where he realizes that an automobile is a conveyance to get him from place to place and not a piece of circus apparatus!

the bully, who, by this time, had crawled painfully to his feet and, seeing that Gus had no intention of renewing hostilities, wanted to uphold his end of the argument.

"How about your own eyes?" Gus asked. "Why didn't you see this man's car approaching the intersection? There's no signboards or anything in the way."

"My eyes are perfect and I can prove it."

"All right, prove it then," snapped Gus. "Stand right where you are and describe the radiator ornament on my car."

The big fellow laughed sneeringly.

"What are you trying to do, kid me?" he growled, staring intently at the metal object. "That's no test. It's just one of those metal bulldogs. One of the front legs is busted off."

Gus, who was standing in front of the big chap but slightly to one side of his direct line of vision, did a peculiar thing while the big fellow was gazing at the radiator ornament. He crouched into a pugilistic attitude and started a swing that would have landed square on the point of the jaw if he had not stopped it a foot short of the mark.

Joe and the other accident victim gasped in amazement, for the big fellow seemed totally unaware of Gus's threatening move.

"I GUESS that settles it," Gus growled at him as the big man finished describing the bulldog. "If you'll take my advice, you won't ever try to drive again. You have what is called 'tunnel vision'. You only see what is directly in front of your eyes—no side vision at all. A normal man can see a moving object that's almost ninety degrees off to one side. You didn't see my fist move toward your jaw just then, and the chances are you never saw this fellow's car at all until it was right in front of you."

"I passed the license examination," said the big fellow uneasily. "That gives me the right to drive, doesn't it?

A. A. HOWARD

President, HOWARD RADIO CO. Says:

Look for this mark on every Radiotron

"Because we are proud of the performance of Howard receiving sets we call their purchasers' attention to the vital importance of their vacuum tubes. We urgently advise that RCA Radiotrons be used in them throughout, for initial equipment and for replacement. In this way the finest reception is obtained."

A. A. Howard

RCA Radiotrons are recognized as standard by the leading makers of fine radio instruments. But it is unwise to use new tubes with old ones. Repeated tests have proved that you will get better results if you completely re-equip your set with RCA Radiotrons once a year at least. By putting fresh tubes in every socket you are assured of balanced reception.

RCA RADIOTRON

RADIOTRON DIVISION

RADIO-VICTOR CORPORATION OF AMERICA NEW YORK CHICAGO ATLANTA DALLAS SAN FRANCISCO

Can't I get glasses to fix the trouble?"

"Sorry, big boy," said Gus sympathetically. "People with tunnel vision are scarce. There's no cure and no way to correct it with glasses. I heard of a fire engine driver who had it without realizing it. He managed to drive the engine for several years, and then he got into a bad smash and the investigation showed his eyes were to blame."

"That's a new one on me," the big fellow muttered. "Still, it would account for most of the accidents I've had. It's cost me plenty of jack fixing up other people's cars after I busted into 'em. Can't even get insurance any more. Guess I'd better get me a chauffeur before I land under the daisies!"

"And if I were you," Gus grinned, "I'd make durn sure that that chauffeur doesn't have the same trouble."

Both of the men's cars were so badly smashed that they had to be towed in.

"How about the little fellow?" Joe asked as they rattled down the road with the first car on the end of the wrecker's crane. "Should a man be allowed to drive a car who is as nearsighted as he is?"

"Sure," replied Gus, "if he's got enough common sense to know his own limitations. In the daytime, with his glasses on, he can see just about as well as anybody. At night, especially when it's raining, he won't be quite sure of what he sees through the rain-covered windshield. He's liable to mistake a post for a man or a man for a post, but if he drives so carefully that it doesn't matter whether it turns out to be a post or a man, he won't get into trouble.

"Farsighted people," Gus continued, "unless they are unusually farsighted, don't even need to wear glasses when they drive. Color-blind people can drive safely enough, but they're up against it when it comes to traffic lights. I know one man who doped out which light was above the other and went by position instead of color. Once, late at night, he was traveling through a strange town, and as he came to the main crossing, he saw a light where he thought the red ought to be, so he stopped. When the lights changed he started forward and went smack into a car crossing in front of him. In that town they had the red light where the green ought to be!"

U. S. Makes Ninety Percent of World's Automobiles

INTERESTING statistics relating to the manufacture and distribution of automobiles were recently made public by the United States Department of Commerce, Washington, D. C. Of the 32,028,500 automobiles in use in the world, 28,551,500, or more than ninety percent, it is stated, were produced by American manufacturers. Approximately one half of the 6,336,843 machines in foreign countries are of American make.

There is, according to these figures, one automobile for every sixty-one persons in the world, an average accounted for by the high ratio in the United States of one automobile for every 4.87 persons. The lowest per capita registration is in Arabia, one state (Asir) having 75,000 persons to each automobile.

Craft Work *with* Newspapers

An Adaptable Material Used in Making Boats, Cameras, Vases, and Other Articles

Hull constructed by pasting many layers of newspaper on framework of thin wood strips built to the shape required.

WHEN used in conjunction with a boiled starch paste, newspaper becomes an ideal material for many construction purposes. From it the writer has made numerous articles, including the astronomical camera and boat illustrated.

First a framework is constructed, preferably of wood, having slats that are placed fairly close together. The spacing of the slats depends, of course, on the desired final strength.

Next prepare a generous quantity of boiled starch paste. Take sufficient water for the amount of paste required and heat to boiling. While this is heating, mix common starch in a small quantity of cold water until it is perfectly smooth and of the consistency of heavy cream. When the water is boiling violently, remove it from the fire and stir rapidly while pouring the starch mixture into it. Keep on adding the starch until the paste is about the consistency of molasses. Use a good and reasonably stiff brush for applying the paste, and coat the wood frame first; then coat the paper with paste on both sides and apply it to the frame. If the paste is of the correct consistency, the paper will absorb it and appear quite wet.

Layer after layer of paper is applied in this manner until from six to twenty or more layers have been used, according to the required strength. The paper should be forced into complete contact with the preceding layer with the paste brush. Apply pieces of all shapes and sizes, torn to shape rather than cut, as the ragged edges are less liable to form ridges on the finished surface.

This astronomical camera was covered by using newspaper strips.

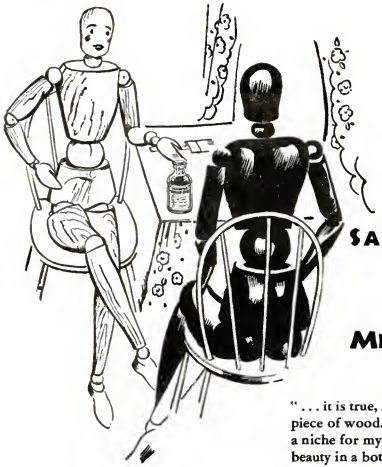
As the glue dries it will cause the paper to contract and the finished article will be found to be very smooth and almost as hard as vulcanized fiber. In spite of its smoothness and hardness, it will not be brittle and therefore will not break easily. The covering can be sandpapered and even filed to remove any inequalities in the surface. Any desired finish can be used.—WARREN N. CRANE.

Strips of newspaper were wound around a wide-mouthed bottle in making this very artistic and practically unbreakable vase.

NEWSPAPER can be used for converting a bottle into a useful and artistic looking vase. Obtain a wide-mouthed glass bottle similar to those in which olives are sold. Prepare the necessary strips of paper and soak them in 1 oz. of liquid glue diluted with 16 oz. of water.

Wind the paper around the bottle, layer upon layer. By putting more paper in one place than in another, the curved shape can be obtained. After the vase is of the desired form, it should be brushed thoroughly with the glue solution and allowed to dry.

The vase is then ready for the decorations, which can be applied in the form of enamel or lacquer. The one shown was enameled yellow with red and green stripes.—ARTHUR SCRIVEN.



SAID MISS PLEBIAN PINE

TO

MISS BRAZILIAN MAHOGANY

"... it is true, madamoiselle, that you are a rare and therefore costly piece of wood. But for all your social position, I too have whittled a niche for myself in the hobbyist's hall of fame. For there is more beauty in a bottle of Johnson's Wood Dye than many of your aristocrats ever dreamed of."

A fanciful monolog, but true as tomorrow!

Craftsmen the world over who know their woods and finishes consider Johnson's Wood Dye much as a stage beauty considers her cosmetics. They would as soon neglect the finish of their handiwork as said beauty would neglect her complexion.

The true, clear color of Johnson's Wood Dye, penetrating deep into the grain, gives to the plainest pine, as well as to the finest mahogany, a subtle richness which every craftsman recognizes and appreciates. No muddy, pigmented scum; just pure, transparent Dye. It is this dependability and certain effect of Johnson's Wood Dye which has led many of the more common woods out of obscurity and the doom of paint or lacquer.

Write for our professional wood-finishing manual. It won't cost you a cent and you're almost certain to learn something new. Mail the coupon.

S. C. JOHNSON & SON, RACINE, WISCONSIN

"The Interior Finishing Authorities"

JOHNSON'S WOOD DYE

S. C. JOHNSON & SON, Dept. (PS 11) Racine, Wisconsin

Gentlemen: Please send me without charge a copy of your professional wood finishing manual.

Name .....

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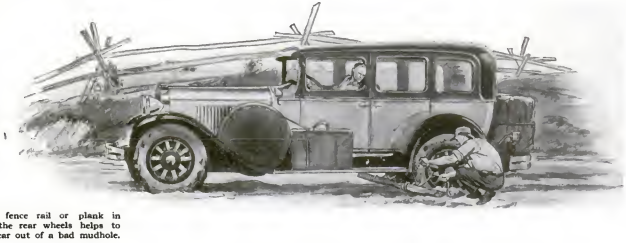
Kinks That Solve Auto Problems



Tying a fence rail or plank in front of the rear wheels helps to get the car out of a bad mudhole.

How to Help the Car Climb Out of a Mudhole—New Ways to Do Simple Repair Jobs—Oiling Piston Rings

AN EMERGENCY method for getting a car out of a mudhole when both rear wheels have bogged down so deep that they no longer have traction is to place a plank or a fence rail in front of the rear wheels and tie it loosely to the spokes. When the car is driven ahead it will climb up on the plank and pass over it. The plank then can be untied and moved to a new position in front of the rear wheels. Repeating this procedure as many times as necessary will get the car out of the mudhole and back on solid ground again.

Oiling New Piston Rings

WHEN the motor is started after new rings have been fitted, extra lubrication should be applied to the rings during the first few minutes. Unfortunately, it is just at this time that oil from the regular lubricating system is very scant. A remedy is to plug one end of the piston pin with grease before the connecting rod is bolted to the crank shaft. The hole in the piston pin is then filled with cylinder oil and the other end plugged with grease.

As soon as the motor is started the heat melts the grease and allows the oil to run out where it will properly lubricate the piston rings during the critical period.

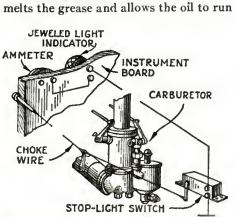


Fig. 2. Installation of a dashboard indicator that flashes when choke is left out.

Each month POPULAR SCIENCE MONTHLY awards a prize of $10, in addition to regular space rates, for the best idea sent in for motorists. This month's prize goes to Roger Meyer, of Fond du Lac, Wis., for his suggestion for oiling new piston rings, shown in Figure 1. Other contributions published are paid for at the usual space rates.

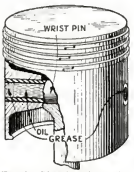


Fig. 1. Plugging piston pin with grease provides lubrication when motor is started.

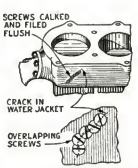


Fig. 3. How a small crack in the water jacket can be closed by a series of screws.

A Choke Indicator

FOR those who forget to open the choke after the motor has become warm, the indicator illustrated in Figure 2 serves as a reminder. An ordinary stoplight switch arm is attached by a wire to the choke lever on the carburetor in such a way that when the choke rod is pulled out the switch is thrown over to the "on" position.

This closes the circuit to the jeweled light indicator, fastened on the dashboard. The glowing jewel will indicate that the choke is out.

Mending Water Jacket

FIGURE 3 shows an ingenious way to close a crack in the water jacket of an automobile cylinder block. A hole drilled at the end of the crack is tapped and a tight-fitting screw is screwed into it. The screw should be cut off flush with the cylinder jacket and another hole drilled so that it cuts through the crack and partly through the first screw. This hole is tapped, a screw run into it, and the same process continued until the entire crack is plugged by the screws. Smear the threads of the screws with a good grade of iron cement before screwing them into the holes.

Repairing Seat Cushions

BY FOLLOWING the method in Figure 4 it is possible to sew a rip in a seat cushion in such a way that the stitches are invisible, and without taking the cushion apart. If the rip has been caused by a broken holding wire this should first be repaired, as indicated. Then the rip should be sewed back and forth, over and under, leaving the stitches loose. After the sewing is completed the stitching can be pulled up tight, beginning at one end. This will close the seam so that the stitches will be hidden.

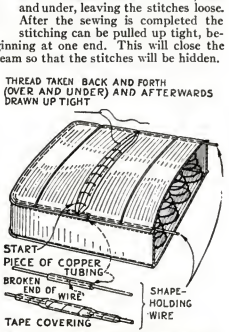


Fig. 4. Ingenious method of mending a rip in a seat cushion so that stitches are invisible.

Specialists made it • • •
Engineers tested it • • •
Instruments proved it • •
and motorists say,
"Yes—the New Mobiloil does last longer"

A year ago, our engineers said: "Our tests prove that grade for grade, the New Mobiloil stands up better and lasts longer in comparison with other good oils."

Last summer we sent investigators to ask this one question of motorists: "What have you noticed about the actual performance of the New Mobiloil in *your* engine?"

"The New Mobiloil lasts longer," was their answer.

What does it mean—this ability of the New Mobiloil to outlast other oils?

Its meaning has more significance than any other single fact about an oil. For, in comparing oils of similar "body," engineers have proved that the oil which lasts longest, also lubricates best.

There is a Mobiloil dealer near you with the grade of the New Mobiloil especially refined for your particular type of engine. His Mobiloil Chart will tell you which grade will most effectively help you keep the first-year feel in your engine for at least 30,000 miles.

VACUUM OIL COMPANY

Makers of high quality lubricants for all types of machinery

the New GARGOYLE

Mobiloil

Keeps the first-year feel in your engine

Mastering the Use of a Circular Saw

Groove Cutting and Joint Making as Embodied in a Chippendale Mirror

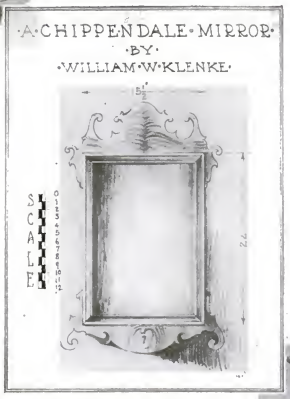
By WILLIAM W. KLENKE

The saw blade is mounted so that the top teeth point toward the operator.

NOW that small woodworking machinery is being introduced so generally in well-equipped home workshops, the amateur cabinetmaker needs to know above all else how to use a circular saw expertly.

The motor-driven saw is the greatest aid a woodworker has. Skillfully handled, it will perform wonders in cutting up stock quickly and accurately, in making joints of many different varieties, and in doing with ease and speed the preliminary operations which are most common in building furniture and most tedious to do by hand.

As an object lesson in the use of the small circular saw, I have chosen a Chippendale mirror. Aside from the handwork needed in assembling and finishing, the frame of this graceful piece can be made almost entirely with the saw and its attachments. The operations are simple and the finished product is useful; so, in making the mirror, not only will a good-looking piece of work result, but excellent practice will be given in machine sawing.



The Chippendale mirror as drawn in pencil by Mr. Klenke, who is the author of *Art and Education in Wood Turning*, and a manual training teacher of wide experience.

As to stock, mahogany and maple are two appropriate woods to use. Extreme care should be taken in selecting the pieces for the top and bottom to see that the grain forms an attractive figure.

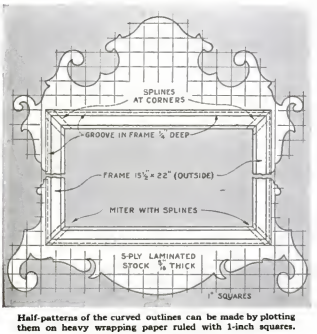
Step No. 1 — Making the Patterns. From the working drawing, lay out full size squares on heavy paper, such as wrapping paper or cardboard; then plot the curves. Cut these patterns out in template form. It will be necessary to make only half patterns of the top and bottom, as the half can be used for both sides. For the top and bottom it is best to use five-ply laminated stock to avoid splitting.

Step No. 2—The Frame. Although the design as it is given for the molding is a good one to follow, you can substitute any suitable stock picture molding of about the same size.

Circular saws are made in three different types—rip, crosscut, and combination or miter. The rip saw is used to cut with the grain. The teeth are rather large and, as with a hand saw, are filed at right angles to the blade. The cut is like that made with a chisel. The crosscut saw has much smaller teeth and, as with a hand saw, the teeth are filed at an angle. This saw is used on all general work except ripping. Both of these saws are set to give clearance. The combination or miter saw, as the name implies, is made up of both crosscut and rip teeth and is usually hollow ground, requiring no setting. The cut made with a good sharp blade of this type will be very smooth, oftentimes good enough for a joint without planing.

If you purchase only one blade, the best advice is to buy a combination saw. There is one disadvantage, however, in

By tilting the table at 45 degrees and placing the molding on its edge, miters may be cut.



Half-patterns of the curved outlines can be made by plotting them on heavy wrapping paper ruled with 1-inch squares.

C & L 158

This blow-torch is especially made and priced for the man who likes to do odd jobs around the house, or to tinker with mechanical things. It will last a lifetime if it is not abused. The usual retail price is about five dollars. Most hardware, electrical and automobile accessory stores have it—or can get it for you quickly. Look for the gold-banded, red handle.

IS THE FEELING FOR FINE TOOLS IN YOUR BLOOD?

DO YOU get a real kick when you pick up a good tool? One that makes working a pleasure? That makes you want to stick at the job? Well, be set to feel that way when you take up a Clayton & Lambert blow-torch.

In a Clayton & Lambert you buy all the exactness and pride that can be put into a blow-torch. You get materials that have proved their value by use. You obtain the result of 40 years' experiment and invention—exclusive Clayton & Lambert improvements. In construction and mechanism, Clayton & Lamberts are made with an eye for long, efficient service.

For instance—the vaporizing chamber has an exclusive vein system for quicker, hotter heat. That makes the torch function better and saves money on your fuel bills. All fittings are built into the tank by a patented method that prevents their falling in or coming out. There's *absolutely no danger* of an explosion with a Clayton & Lambert torch. Even the most delicate part—the gas orifice—is fool-proof. In the No. 158 the orifice has a guard. The slightly higher priced No. 32 has a patented control valve so that you'll never ruin the torch by a careless twist of your wrist. And when you close the valve you automatically clean out the carbon.

The next time you're in a hardware or electrical store look for the blow-torch with a gold-banded, red handle. Be sure of the handle—it marks a Clayton & Lambert. Then you're getting the largest selling torch in the world.

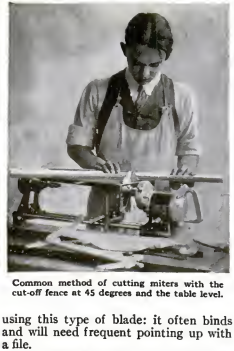
C & L 32

This is one of the most popular blow-torches we have ever made. It is more expensive than the 158 because it is made for much harder use. It is designed for the man who uses a blow-torch in his daily business and demands not only excellent performance but rugged ability to stand rough handling. 32 contains the most advanced, patented C & L blow-torch improvements.

CLAYTON & LAMBERT

MANUFACTURING COMPANY, Detroit, Mich.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8



Common method of cutting miters with the cut-off fence at 45 degrees and the table level.

using this type of blade: it often binds and will need frequent pointing up with a file.

For this work we shall use the combination or miter saw. Set the cutting-off fence so as to make a 45° cut. To do this, make a trial cut on two scrap pieces of wood and place them together; if they test square, the cut is at exactly forty-five degrees. With a slow stroke make all the miter cuts. Next, cut the grooves for the splines by lowering the blade to about ½ inch high and holding the miter flat on the table. As a guide for this operation, use the ripping fence. The upper sketch on this page should be consulted for the form and application of the spline.

Step No. 3—Assembly of Frame. Glue temporary ears (triangular blocks of wood) on all the corners, so as to have something on which to get a grip when clamping up the frame. By temporary ears in cabinetwork, we mean pieces of soft wood that are cut so that the grain in them runs the long way and are glued in place. The ears should have two angles of 45° each and one of 90° as shown in the sketch.

Allow the glue at least four or five hours to set. Next, assemble the entire frame, using plenty of the best glue. Test the corners to be sure that they are square and that there is no twist to the frame. Be certain that the grain in the splines runs the short way, as shown; this adds much to the strength of the frame. Make the splines a little wide at first and cut them to shape after the glue has hardened.

Step No. 4—Cleaning up the Frame. By means of the sanding disk, clean up the corners, especially where the ears were fastened and where the splines projected.

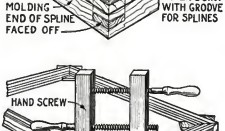
Step No. 5—Cutting the Grooves. Cut the groove on the top and bottom edges and part way on both sides so as to receive the head and bottom pieces.

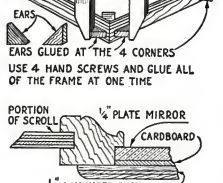
Step No. 6—Cutting Out the Curved Designs. With the template, transfer your curved design to the wood. Next, cut just outside the lines with a jig or band saw. If you are working with a small machine, it will be necessary to place the design on both sides of the wood, so as to be able to work from both sides.

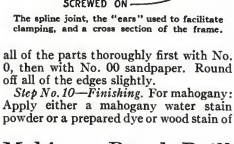
Step No. 7—Truing up the Edges. Use a drum sander on all of the curved edges possible; the inaccessible curves will have to be cleaned up with a file and sandpaper. If you have done the sawing carefully, there will be very little sanding to do.

Step No. 8—Assembly of Scrolls. First, put plenty of glue in the groove and on the edges to be glued; then, force the various parts together. Be careful to wipe away all of the excess glue after the parts are assembled.

Step No. 9—Cleaning Up the Work. If there is any excess glue on the work, remove it with a sharp chisel. Sandpaper







The spline joint, the "ears" used to facilitate clamping, and a cross section of the frame.

all of the parts thoroughly first with No. 0, then with No. 00 sandpaper. Round off all of the edges slightly.

Step No. 10—Finishing. For mahogany: Apply either a mahogany water stain powder or a prepared dye or wood stain of

The grooves for the head and bottom pieces are cut after the frame is assembled and cleaned.

first-class quality. Brush on a very thin coat of white shellac. When it is dry, sand with No. 00 sandpaper. In order to fill the grain in the wood, a paste wood filler must be applied. Shellacking is the next process. Apply three thin coats of shellac. After the first and second are dry, rub each with No. 00 sandpaper, but for the last coat use a mixture of powdered pumice stone and crude or machine oil. If you have a spraying outfit available, spray on a clear lacquer instead of the application of shellac.

For an antique finish on maple: There are two methods that I believe are outstanding. One is quite similar to the method stated above for mahogany except that an amber stain is used. Since maple is a close-grained wood, no filler need be applied; the shellac will fill any small pores that may be present. The other method is to use an oil walnut stain, and after it dries rub the high-lights almost through to the bare wood with No. 00 sandpaper in order to give the effect of a worn surface. The finish then is applied as in the other cases.

This article is the fourth of a series in which Mr. Klenke, through the courtesy of various manufacturers, demonstrates the use of many new home workshop machines of both combination and individual types.

Making a Bench Drill from a Bottle Capper

THIS bench drill was made from a substantial bottle-capping machine costing about three dollars and an ordinary hand drill. The capper has a ⅜-in. rod, is 20 in. high, and stands on a 4 by 6 in. base.

To make a drill like this, remove the head of the capper, leaving the headless screw in the rack. Cut off the handle of the hand drill where it joins the rod, and drill and tap the rod to fit the headless screw. Be sure the threads run at least ½ in. into the metal.

Place a metal washer between the rod of the drill and the rack of the capper and file

A hand drill is put in place of the cap holder on the bottle capper.

it thinner until the handle of the drill rests in a convenient position. For a right-handed person the handle of the drill wheel should be on the right, and the lever handle on the left, so remove the lever handle and clamp and reverse them.

Most stands will allow the lowest part of the drill chuck to be changed from 4½ to 7¼ in. above the base by adjusting the clamp. The rack and pinion move the chuck an additional distance of 1½ in.

A small motor can be mounted on the part just above the rack and belted to the rim of the large gear wheel.—N. C. PIERCE.

How to Use Your Hand Saws

Told by the Makers of "The Saw Most Carpenters Use"

FOR better work, you need Disston Hand Saws, made with Disston skill from Disston Steel: the world's great cutting steel, produced only by Disston in Disston's own steel furnaces.

The *new* Disston Hand Saws are finer now than ever before—improved in every feature. Lighter blades, for easier cutting; narrower blades save user's strength; true-taper ground, faster cutting; thin, yet stiff; true running; new weatherproof-finish handles; better balanced. They will run with less set, cut faster, cut easier and stay sharp longer, than any other hand saws ever made.

Ask for Disston! Not only hand saws, but every other type of saws for bench or machine work.

Files for the Metal Worker

Every kind, size and style Disston 8-inch Mill File, bastard cut, is *the* for sharpening axes, lawn mowers, garden tools, and general work in the home and shop. Excellent for finishing metal surfaces. 25 cents each.

"The Saw Most Carpenters Use"

The two handiest saws for the home workshop are the 26-inch 8-point for cross-cutting, and the 26-inch 5½-point for ripping. You will need these on almost every job. The popular "D-8" Lightweights cost $3.45.

Hints on Using a Hack Saw

For cutting pipes, bolts, nails, curtain rods, etc. Strain blade tight. Cut on forward stroke. Disston No. 30½ Hack Saw Frame takes 8" to 12" blades; $2.10. Blades, 8", 55c doz.; 10", 65c doz.; 12", 75c doz.

USE the right type of saw for the work: a Disston cross-cut saw for cutting across the grain of the wood, and a rip saw for cutting with the grain. The teeth are shaped differently, and work differently. For all-around work, use a cross-cut saw with 8 points to the inch, and a rip saw with 5½ points to the inch.

Keep your saws *sharp* and set properly. To start the cut, rest blade on waste side of line, support side of blade with left thumb, and draw saw toward you a few times until a slight groove is formed; then cut straight.

In cross-cutting, it is best to maintain an angle of 45° between edge of saw and face of work. Stand so saw, arm and shoulder are in line with cut. In ripping, keep angle of 60° between saw and work. (See illustrations.)

Teeth of cross-cut saw and proper sawing angle

Teeth of rip saw and proper sawing angle

Take long, easy strokes. Don't twist or force blade in the cut. Raise work high enough to keep blade from striking floor. Remember that a Disston saw is a fine tool: do not throw it around. Keep your saw oiled and hung up when not in use.

Good hardware merchants everywhere sell Disston Saws. "The Disston Saw, Tool and File Book," sent free, tells you how to use them most efficiently. Write to us for it.

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The Back Saw, with fine teeth and stiff back, enables you to do smooth, accurate cutting of mitres, grooves, etc., for making furniture, picture frames, etc. Disston No. 4, 12" size, 5" under back, 14-point, costs $3.00.

For Finishing Wood Surfaces

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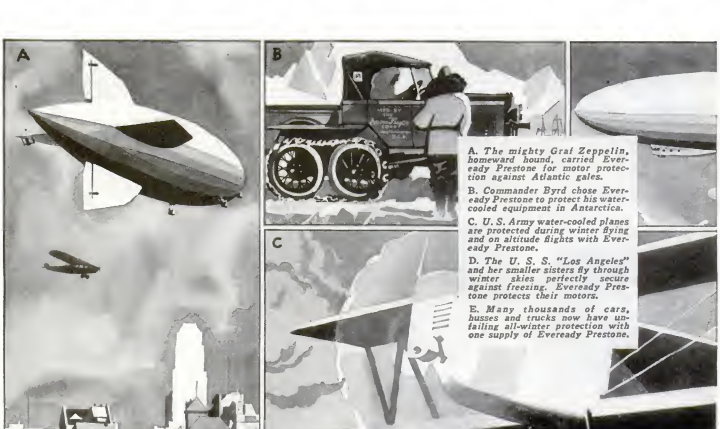

THE unfailing, harmless protection against frozen motors provided by one supply of Eveready Prestone, has won for this perfect anti-freeze the highest endorsement wherever it has been used. When giant dirigibles take the air in winter weather, when a water-cooled Army plane ventures into frigid altitudes, when motors must operate in the intense Antarctic cold, Eveready Prestone is the first thought for protection. It possesses *all* the properties which the National Bureau of Standards has pointed out as essential for an anti-freeze.

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The discovery of Eveready Prestone has given every motorist the opportunity to discard freezing worries. One supply of this perfect anti-freeze will keep his car in complete safety, *all winter*, no matter how soon it is put in the car or how long winter lasts. Its unfailing protection makes it unnecessary to buy Eveready Prestone more than once—a single investment provides certain, harmless, all-season insurance against any possibility of a freeze-up.

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It is time now to have Eveready Prestone in your automobile. Before you add anti-freeze, however, be sure your car is *ready* for winter. Cold-weather driving demands free-flowing, winter-grade lubricants in crankcase, transmission and differential. Battery, spark plugs and ignition cables ought to

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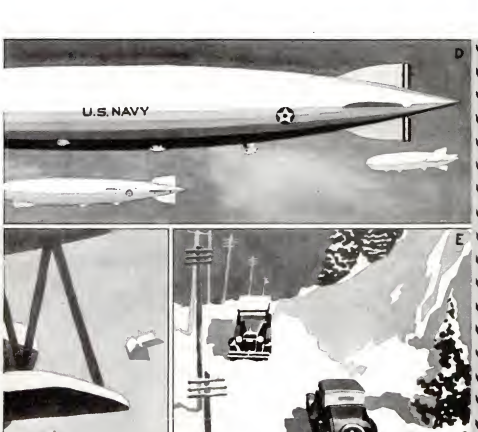

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be at their best. The all-important cooling system should be in perfect order. Have the radiator and water-jacket *clean* and *tight*—see that all of last summer's collection of scale and rust is flushed out. Vibration and jar tend to loosen joints and hose connections. Make certain that these and all pump parts, gaskets, drain cocks and radiator are absolutely free from leaks. Then add water and one purchase of Eveready Prestone, and your car will be ready for all winter.

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Your car needs this simple preparation and a supply of Eveready Prestone *right now*. Don't put it off until freezing weather forces you to find protection. This perfect anti-freeze is not affected by warm-weather driving. Eveready Prestone is an entirely different anti-freeze that contains no alcohol or glycerine. It is sold in *pure, undiluted* form, and because of its efficient protective qualities one to two gallons, depending on radiator capacity and lowest temperature encountered, is enough for most makes of cars. *You can buy Eveready Prestone at any garage, filling station, automotive supply store, or hardware store. See about it today.*

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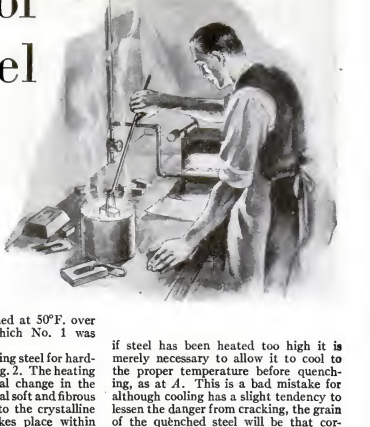
Hows and *Whys* of Hardening Steel

Heat Treating Tools to Insure Maximum Utility and Durability

By HENRY SIMON



Tempering and hardening is not a hit or miss process but should be carried through with extreme care. It requires knowledge of both theory and practice along with a lot of patience.

NO OPERATION around the shop is more important than the heat treatment of steel. The process determines in a few minutes what the work of hours and days shall be worth. Though many mechanics look upon it as a sort of lottery, hardening, when properly carried out, is as certain of success as any shop operation, and almost anyone can obtain excellent results merely by understanding and applying a few simple rules. Practice and theory must go hand in hand. We must be familiar with both.

Many very good mechanics who have no trouble in getting their work hard regularly fall short of bringing out anything like the possibilities of the steel, simply because of failure to appreciate what happens in hardening. The two dies of Fig. 1 *A* may both be "file hard." Both may be of the same steel, and drawn to the same temper. To all appearances, they are as much alike as two eggs. Yet as shown at *B*, No. 1 may cut twice as many blanks as No. 2 merely because No. 2 had been quenched at 50°F. over the proper heat at which No. 1 was hardened.

What happens in heating steel for hardening is shown at *A* in Fig. 2. The heating brings about an internal change in the steel, whereby the original soft and fibrous grain is transformed into the crystalline state. This change takes place within only about 20°F. of what is called the *upper critical range*. This range always remains exactly the same for the same steel. With ordinary carbon tool steel, it is around 1350°F. The steel must always be quenched at a point somewhat higher than that of the highest point on the critical range. It is useful to note in passing that, as indicated at *B*, the higher the steel is in carbon content, the lower is the temperature at which it is quenched.

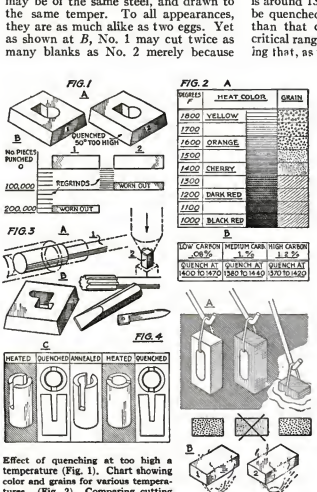
The point above the critical range where steel first properly hardens is where the grain is finest and the steel strongest. Any further heating, though it will somewhat increase the hardness, will cause so rapid a drop in strength that the benefit is usually far more than offset by the accompanying condition of greater brittleness. Heating the steel from 50 to 100°F. above the low quenching point may be useful in giving wear-resisting qualities to a moving part such as the piston *1* at *A* in Fig. 3, or in a contact or pressure member like the spacer *2*, but with cutting tools such as those at *B*, heating even 50°F. too high is likely to overheat the tool and will consequently lower its value.

In this connection, Fig. 4 points out two facts about which many mechanics have erroneous ideas. Some believe that if steel has been heated too high it is merely necessary to allow it to cool to the proper temperature before quenching, as at *A*. This is a bad mistake for although cooling has a slight tendency to lessen the danger from cracking, the grain of the quenched steel will be that corresponding to the highest temperature to which the piece has been raised, as at *B*.

The second mistake is to think that steel which has been heated to, or quenched at, too high a heat can be restored by tempering. It is true that a carefully tempered piece of poorly hardened steel may still be superior to a poorly tempered piece of carefully hardened steel; but, as shown at *B*, tempering can never restore the grain of the steel to what it should be, and with equal tempering, piece No. 1 will be greatly superior to No. 2. In other words, once steel has been heated too high—and that may still be a long way from what is ordinarily called *overheated* and still farther away from *burned*—the damage is done, and nothing short of annealing can cure it.

EVEN annealing frequently fails to bring the work back to exactly its original condition, because it will always leave some deformation which is likely to be aggravated by a second heating and quenching, as illustrated at *C*. The big question, therefore, is what the proper quenching temperature is, and how we shall know it when we see it. Books are likely to use a statement to the effect that it should be *about 1420°F.* The man in the shop will probably tell you "a good cherry red." All of this is fine as far as it goes; only many of us have no heat measuring instrument and feel that it is impossible to tell the temperature within 100°F. from the color, let alone to identify it from a verbal description.

Must the mechanic who has no pyrometer then put out inferior hardened work? By no means. Heat-measuring instruments are indispensable as an aid in modern mass production, in research, and for some special purposes, but no instrument is necessary in hardening the ordinary run of tool steel parts in the



Effect of quenching at too high a temperature (Fig. 1). Chart showing color and grains for various temperatures. (Fig. 2). Comparing cutting tools and pressure or contact tools (Fig. 3). Effect of cooling down to the right temperature (Fig. 4).

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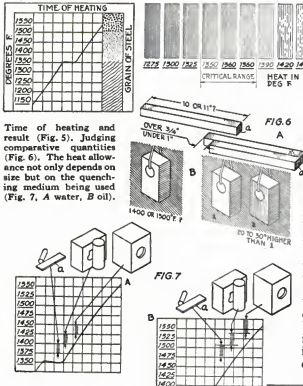


Time of heating and result (Fig. 5). Judging comparative quantities (Fig. 6). The heat allowance not only depends on size but on the quenching medium being used (Fig. 7, *A* water, *B* oil).

general shop. Moreover, in any such miscellaneous work, nothing can take the place of the eye and judgment of the hardener, even though it is a fact that the most experienced eye cannot tell the actual temperature of a piece of steel within 100°F., while an instrument can get to within 10 or 20°F. very easily.

The explanation of this paradox brings us to a closer scrutiny of the critical change. While Fig. 2 showed *what* happens to steel in hardening, Fig. 5 illustrates the *how* and *why*. In heating the steel, the first input of heat is entirely used up in raising the temperature, but the temperature cannot keep on rising forever without some change in the steel. It has already been noted that with carbon steel, this change occurs at about 1350°F. With alloy tool steels, the change takes place anywhere from 1350 to 1800°F., depending upon the composition of the steel. Now, though this transformation always takes place within a rise of about 20°F., it requires time and absorbs energy.

WHILE this transformation is taking place and more heat is being poured into the steel, the steel does not grow appreciably hotter. Its temperature may even drop slightly, since all of the heat is now being used up in bringing about the molecular rearrangement. The moment the transformation is complete and the internal work is completed, the temperature of the steel begins to rise again. Expressed as a graph such as a heat-recording instrument would produce, the curve is like that of Fig. 5 *A*, which plainly shows that, though the change requires an appreciable amount of time, it all takes place within a very few degrees. Or, to express the same thing more graphically as at *B*, there will be a distinct halt in the temperature rise of the steel, and therefore a plainly observable *dwell* in the heat color.

With these simple facts once clearly grasped and always in mind, it becomes possible to determine with perfect certainty the only part of the temperature that really interests the hardener, namely, the narrow *quenching range* right above the completion of the transformation or decalescence. This may be done with a degree of accuracy which will surprise those who stand firmly on the book truth that the eye cannot tell the heat from the color within 100°F. It cannot—and it need not.

Let us consider a parallel case. Few could tell the length of the bar *a* at *A* in Fig. 6 within an inch without measuring, but anyone can tell the *difference* between bar *a* and bar *d* within a quarter of an inch. It is similar in hardening. With a little practice, the critical change in a piece of tool steel can be clearly recognized as a distinct halt in the rise in heat shown by a corresponding dwell in the heat color.

"But," it may be asked, "if the change is complete at one certain temperature, why should there be the quenching range of 100°F.?" This question brings us to another point which is the subject of considerable argument. While the end of the upper critical range marks the earliest point at which to quench, it is very necessary to understand that it is not the point at which any particular piece of work can be quenched. The reason is that, as it is not possible to extract all of the heat from the steel at once, it is necessary to make a suitable excess heat allowance which not only depends on the size of the tool or die but on whether it is quenched in water (*A*, Fig. 7) or oil (*B*).

INDEED, judging the amount of the heat allowance is the most difficult part in the heat treatment of tool steel. It is more difficult to determine than the critical range because it requires judgment in addition to "eye," and this judgment is beyond any instrument. Only practice can here make perfect. It is possible, however, to arrange and shape this practice so that a lot of experience can be gained in a little time and without the usual heavy casualties in the way of spoiling expensive parts.

The best treatment of long slender work often presents serious difficulties, owing to the tendency of some pieces to warp in quenching. It is difficult to lower such light work into the bath without causing it to be moved sideways in the quenching medium. Even a slight movement is often enough to spring the work.

In many such cases the trouble can be avoided by a very simple expedient. It consists in hooking a weight to the end of the work to cause it to move straight up and down in the bath. There must be, of course, some way to attach a wire hook or loop at each end of the piece. Where there is no other footing, such as a tapped hole, into which a pin for holding the wire can be screwed, it will be necessary to drill a small cross hole at one or both ends. The weight, made similar in shape to a plumb bob, is also provided with a hook, and should be several times heavier than the work.

The work is heated as usual. As it is removed from the fire, the weight is hooked in and the work quenched. The symmetrical streamline form of the weight checks the tendency of the work to enter the bath in any other way than straight down, and thus prevents any swinging movement. Provided the heating has been even and ordinary care is used in lowering the work into the bath this will be found in most instances to cure the trouble.

It is of course possible to use the best method in the wrong way. If the wire-connecting loops are not made straight, they may cause the piece to hang out of true; and if a large flat weight is used, it may let the work side-slip in the liquid and thus become bent.

In the December issue of POPULAR SCIENCE MONTHLY Mr. Simon will outline a program of practice in the judging of correct heat allowances.

Old Bill Says—

A GOOD mechanic knows that a surface plate is not an anvil.

Look on your notebook as a useful tool. It is certain to help you later on.

You will save filing when you are shaping to a line if you use your magnifying glass, for a few thousandths will look like a thirty-second of an inch.

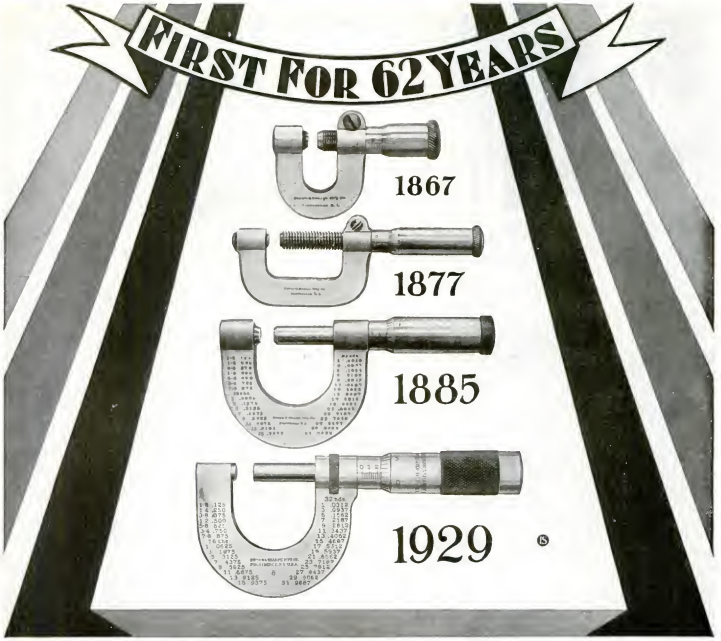
Curved work can oftentimes be filed in a drill press with a round file held in the chuck and run at a medium speed.

A good job done in a whole day is better than half a job done in less time.

A radial drill press can be used for grinding bulky work where more accuracy is required than is possible with a portable grinder. Hold a cup wheel on a short arbor and run the spindle fast while the arm is swung back and forth.

You can't have an accurate die without an accurate template.

A poor blueprint is no excuse for poor work.



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Our new Small Tool Catalog No. 31 illustrates over 2300 useful tools, including over 400 different micrometers. Ask your hardware dealer for a copy or write to us. Address Dept. P. S., Brown & Sharpe Mfg. Co., Providence, R. I., U.S.A.

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Hammering a Disk into a Vase

The Magic Process of "Raising" Sheet Metal into a Variety of High and Graceful Shapes

By EDWARD THATCHER

FOR those who are interested in art metal working, the raised vase form illustrated in Fig. 1 presents an ideal problem.

The dimensions given in the article and drawings refer to a vase made by the writer. However, it is not necessary to follow this exact form; as a matter of fact, it would probably be well for those attempting their first raised piece to work without any special design and just attempt to raise the form up to the required height.

Fig. 1. A vase raised by Mr. Thatcher from a single 12-in. copper disk.

The vase illustrated is made from a disk of No. 16 gage copper, 12 in. in diameter. On this a circle 3 in. in diameter for the base is scribed (Fig. 7). Mark the center with a center punch so that it can be referred to later on in the process.

Annealing has much to do with the final success of the work. Each time the work has been completely covered by hammer blows it must be annealed.

In annealing, care should be taken to heat the stock until red. For heating several methods are available. A large blow torch may be used, or the work may be heated in a blacksmith's fire. If you work in the country, a wood fire will serve, or the work can be placed in an ordinary heating stove.

While water can be used for the quenching, an acid pickle is better. The pickle will remove the dirt and scale from the work while it is being quenched and thus save the labor of cleaning the metal by scrubbing it before the hammering process is continued.

When very hot metal is plunged into acid, the liquid is likely to splatter because of the formation of steam. In using acid, therefore, it is best to shield your face and clothing with a piece of wall board. Keep the acid away from your tools also, as acid charged with copper is not the best thing for hands, tools, or clothing.

Anneal the disk thoroughly before beginning to hammer.

The stake shown at the bottom of Fig. 2 is used at the beginning and is not changed until the vase has reached a height of 5¼ in. and is 8¾ in. in diameter at the top. In metal raising allow the stake to support the work as much as possible.

A large silversmith's hammer is necessary for this part of the work,

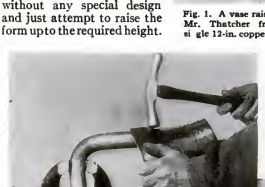


Fig. 3. The stake and large silversmith's hammer used to raise the sides of the vase.

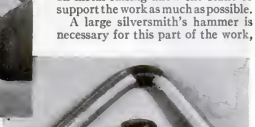
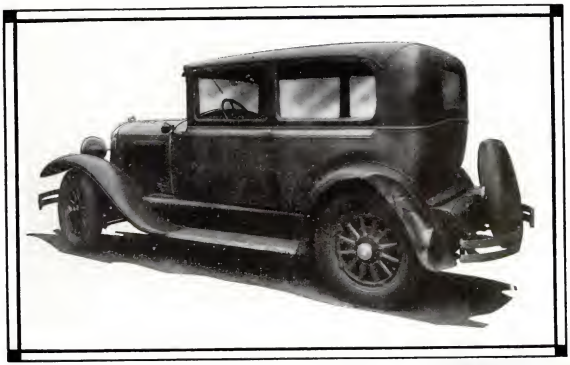


Fig. 2. The lower stake is used to start the vase, the upper after the disk has become bowl shaped.

and, indeed, for the larger part of the hammering. The hammer blows are struck four in a set, and the last blow is allowed to rest on the work. Use the hammer to hold the work while the hand is shifted to a new position. Ease in hammering comes when one learns to take advantage of the natural rebound of the hammer and, by simply applying enough force on the descending stroke, allows the hammer to hit with all its weight.

Fig. 4. Turning in the shoulder with the hammer. Note particularly how the vase is held on the stake.

As the hammering progresses, be careful to keep the form of the base. Do not forget to anneal the stock frequently, for the time spent in this way will be saved by the easier working of the metal. After each anneal-



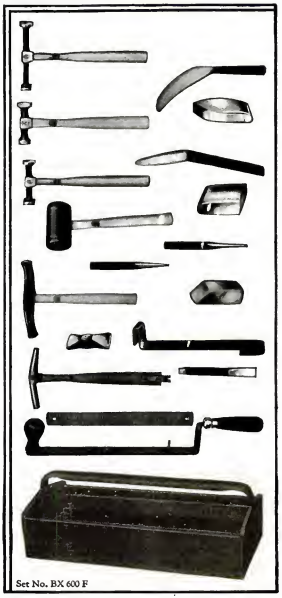
"A 45 Minute Job"

TODAY, a battered fender is a common occurrence. A few minutes in an up-to-date service shop will often make it as good as new. Almost every garage offers this body and fender repair service.

To take care of these mishaps, Stanley has designed a complete line of Body and Fender Repair Tools to fit every place in automobile bodies and fenders.

Mechanics—if you aren't already equipped to render this body and fender service here is your opportunity to start a real Body and Fender repair department. Our new catalog No. 26 shows many new tools which have been added to simplify your work. Send for an up-to-date copy.

The Stanley Rule & Level Plant
New Britain, Conn.



Set No. BX 600 F

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STANLEY TOOLS

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ing rescribe the circle for the base and flatten out the bottom on a hardwood cylinder.

The second operation can be accomplished on a stake made from a discarded steel shaft as shown in Fig. 2. The process is to shape the bowl and to bring it to the right height; this is done as shown in Fig. 3. Hold the work in such a way that it is tilted up slightly at the point where the hammer is to strike. If it is held flat on the stake, the blow will enlarge the form. The blows should be such that the metal is driven down and in.

Fig. 5. The second operation in turning in the graceful shoulder.

At this point you may find that the one side of the vase has become higher than the other side. If this is the case, scribe a line around it with the surface gage and cut off the excess metal.

After the vase has been shaped and brought to the right height, the shoulder can be turned in. The stake used in this operation is shown in Figs. 4 and 5. The work is hammered and annealed as before. The hammer blows should start at the shoulder line. Careful work is necessary at the shoulder and neck, and a template should be used frequently.

If the vase loses its round contour it can be squeezed into shape by placing it in a woodworking vise. The sides should now be planished before proceeding further.

Fig. 6. Using a rounded stake and hammer to turn the edge.

The next operation, that of turning back the edge, is shown in Fig. 6. It is difficult and should therefore be done slowly and with the utmost care. If the turning back were done quickly, small cracks might appear, and these would become larger while the final shape was being obtained. The stake used (Fig. 6) is made from a flat iron bar by filing the end so that it is smaller than the space that it is to fit into and of the same shape as the turned-back edge.

A small silversmith's hammer is needed until you get the metal well rounded over the stake, an operation which should be done gently. The flat planishing hammer is then used to smooth all the surface and form beautiful facets on the metal. (See "Hammering Bowls," P. S. M., Sept. '29, p. 92.)

The work is now ready for polishing and buffing. If desired, an even coat of lacquer may be applied, as this will stop the formation of the copper oxide and thus preserve the finish. Care should be taken to be sure the coat is applied evenly over the entire surface.

Though the two methods now to be explained are not part of the art of raising, they will be of interest to the metal worker.

Instead of being hammered from one piece of metal, old teakettles were sometimes made by bending sheet metal around in an inverted lamp-shade shape and joined with a brazed dovetail joint (soldered with molten brass). Being soldered in this way, the metal could be hammered over at the shoulder and in at the bottom. The bottoms of the kettles were made by soldering a flanged disk to the body. Lids were made from disks beaten to the form of wooden molds.

Many Chinese vases were made in this way. In fact, old pieces from all over the world seem to have been made by using this dovetail construction.

Another way to shape metal into teapots, vases, and similar forms is to spin it. This is purely a mechanical process and is quite different from the shaping of metal by raising it. A disk of metal is placed in a special lathe, where it is held against a metal or wooden mold which revolves with the work. A specially constructed steel tool is then held against the work and forces it down gradually into the form of the mold. The work is removed frequently and annealed, to allow easier working and to prevent the metal from cracking or splitting under the strain. The surface is often marked with a hammer to give it a hammered effect.

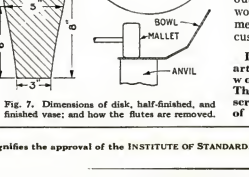

Fig. 7. Dimensions of disk, half-finished, and finished vase; and how the flutes are removed.

Many pieces of metal work are made in this way, but neither the dovetail construction nor the method of spinning turns out the beautiful work that a real metal raiser is accustomed to make.

In a forthcoming article on art metal working, Mr. Thatcher will describe the process of soft soldering.

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Needs These ATKINS "Silver Steel" Saws!

WHEN you start a home workshop, or buy new tools, it will pay you to select saws from the ATKINS line—at your Hardware Dealer's.

Only in ATKINS Saws do you get the world-famous "Silver Steel," which cuts faster and easier, holds its edge longer, and actually outlasts two or three ordinary saws.

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Hack Saw Frames with the new ATKINS Silver Steel Blue-End Blades which have revolutionized metal cutting! They cut TWICE as fast and last SIX times as long as ordinary blades.

Circular Saws—cross-cut, rip, or mitre type—in hundreds of sizes, for the small home workshop power outfit, up to the largest lumber mill saw. All are of Silver Steel, to cut faster, stay sharp, and last longer.

Back Saws for fine work in cutting mitres, etc.! Dado Heads for power outfits, to cut smooth grooves speedily! Band Saws in narrow widths for scroll sawing! Circular metal-cutting saws! Machine knives for workshop planers! Files with sharp, hard teeth that cut faster! Cabinet Scrapers of Silver Steel! Saw Filers and Saw Sets! Dozens of other fine tools for home craftsmen.

See the ones you need at your Hardware Store. Look for the ATKINS name on the blade. It's a sure guide to better value and extra service.

ATKINS "400" and "401" are world's finest Hand Saws. Silver Steel Blades. Perfection Handles—no wrist strain.

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A New Way to Emboss Leather

Heavy Linoleum Is Used for the Dies—The Process Applied to a Small Key Case

By
F. CLARKE HUGHES

The wet leather, die, felt pads, and wooden blocks are placed in a vise, and the pressure applied by screwing up the jaws.

BY CARVING simple dies from heavy linoleum, it is possible to prepare beautifully embossed leather articles without the tedious work of hand-tooling them, which was the only process heretofore available to amateurs interested in craft work.

An example of this new method is the leather key case illustrated. It is intended to hold either one or two keys, for example, a locker and a car key. Other larger and more elaborate articles can be made in the same way at trifling cost compared to the value of corresponding novelties if purchased in an art leather store.

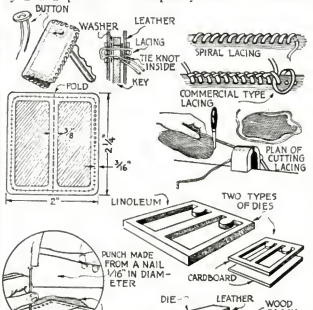
The special leather sold under the trade name of "tooling calf" is the most satisfactory material; this may be bought at most large leather shops. If tooling calf cannot be obtained, some other suitable variety may be selected from the stock carried by a shoemaker. Even the leather taken from a pair of old shoes or a bag will serve the purpose, for after being dyed and polished it completely loses the appearance of old salvaged material.

The die is made as shown by cutting the design into the smooth face of a heavy piece of linoleum. An alternative way is to use two pieces of cardboard as shown. Also illustrated is the way to use the die with felt pads and wooden blocks. The pressure needed can be obtained by using a vise or a letter press, if one is available. The leather should be thoroughly wetted before pressing or embossing.

For the lace in the edges, kangaroo and wallaby skins are the two most commonly used leathers. However, any thin leather such as kid or goat is suitable if dyed black and waxed. The method of cutting the lace and two forms of laced edges are shown.

The holes for the lace in the edges may be made with a regular leather punch or with a nail filed flat on the end. In either case the holes should not be larger than 1/16 in. in diameter or more than 3/16 in. apart.

When embossed and laced, the whole case should be polished with ordinary shoe dressing or a little floor wax.



The key case, methods of lacing, two types of dies, and other details. The leather should be kept taut while cutting the lace.

OFTEN a varnished or waxed floor becomes worn in places where traffic is heaviest, while the remainder of the surface is in practically perfect condition. Wash the worn places with gasoline, then sandpaper them lightly, and wax or varnish again to correspond with the original finish of the floor. After the first gloss wears off, no one will suspect that any patching has been done.—C.A.K.

The rack provides a place for everyday shoes; the box, for those used less often.

A Combination Shoe Box and Rack

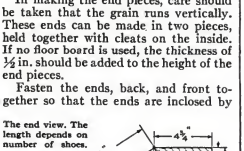
THIS combination shoe box and rack provides a handy place for shoes in everyday use and allows less frequently needed footwear to be stored in a dust proof container.

To estimate the inside length of the box, multiply the number of pairs of shoes by 9 in.; the other dimensions are as shown on the drawing. Although it is most practical to have a back and bottom, they may be left out and the box ends fastened to the wall and bottom of the closet.

In making the end pieces, care should be taken that the grain runs vertically. These ends can be made in two pieces, held together with cleats on the inside. If no floor board is used, the thickness of ½ in. should be added to the height of the end pieces.

Fasten the ends, back, and front together so that the ends are inclosed by

The end view. The length depends on number of shoes.



the front but inclose the back, allowance being made for the floor and baseboard moldings.

The top and bottom next can be put in place, after the top has been beveled to accommodate the lid.

The butt hinges for the lid should be spaced about 12 in. apart.

The rack should be thoroughly sandpapered. For a finish any good penetrating wood stain or dye of the desired color may be used, followed by several coats of shellac, varnish, or clear brushing lacquer.—SAMUEL GORE.

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Recognized everywhere as the standard outfit for home and commercial use!

Jig Saw Attachment for the Workace Electric Woodworker $10

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The most complete all-electric woodworking shop made. It's guaranteed for one year against defective parts and you can have it for only $9 down. The Workace is fast, accurate, powerful and easy to work with; can be made to pay for itself either as a hobby or as commercial woodworking equipment. Nothing like it sold or advertised. Send for complete illustrated description of the Woodworker and other portable machines.

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½" Drill Chuck
½ H.P. G.E. Motor, 110-Volt, A.C., 60 Cycle.

Endless V-Belt, two 4" and one 2¼" V-Belt Pulleys, Cast Iron Sub Base and 10 ft. Cable with separable Plug. The Planer and Circular Saws are each complete units and may be purchased separately at the correspondingly low price of $25.00 each.

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Workace Radial Saw quickly set at any angle..... $140
Cast Iron table $10 extra
Cast Iron legs $15 extra

Workace high speed, direct drive, portable Electric Shaper $95

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Complete with motor $60

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Storage *for* Garden Produce

By L. M. ROEHL

Assistant Professor of Rural Engineering, Cornell University

Shelves arranged in this manner allow ample space for storing a variety of fruits and vegetables. Note the potato crates in the lower right corner.

IF YOU cultivate a vegetable garden of any size, it is highly desirable to construct a vegetable and fruit storage room in the basement of your house. A plan for such a room is shown in Fig. 1, the size suggested being 8 by 10 ft.—large enough for most family requirements.

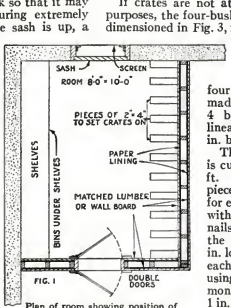
A corner of the basement should be selected, if possible, so as to require building only one side and one end. By the use of one basement sash, ample ventilation is provided. The window is screened to prevent entry of flies and vermin, the screen being left on permanently. The sash is hinged at the top and provided with a hook so that it may be kept open except during extremely cold weather. When the sash is up, a piece of burlap may be hung over the window to darken the room without seriously interfering with the circulation of air.

The framework of the wall is made of 2 by 4 in. material. Each side is covered with building paper and matched lumber or with wall board, which prevents the heat from the furnace from raising the temperature of the vegetable room.

By the use of two doors, as indicated in Fig. 1, the doorway is sealed against the circulation of air. The doors may be made of 1-in. matched lumber, and should be well strapped and braced.

Potatoes keep better if they are in crates than if they are dumped on the ground or floor of the cellar. Place 2 by 4 in. pieces or 1 in. thick boards on the ground or floor where it is desired to set the potato crates. If merely dropped in place, the pieces of wood may be removed easily for cleaning the room. For only one row of crates placed along a wall, pieces from 12 to 17 in. long will do. If two rows are required, the pieces need to be from 30 to 34 in. long. It is preferable to place a second row of crates on the first, to save floor space.

If crates are not at hand for storage purposes, the four-bushel crate or bin, as dimensioned in Fig. 3, is suggested. Since a bushel of potatoes contains 2,688 cu. in., a crate for holding four bushels may be made of one piece 2 by 4 by 12 ft., and 42 linear feet of ¾ by 4 in. boards.



Plan of room showing position of shelves, window, bins, and racks for supporting crates and boxes.

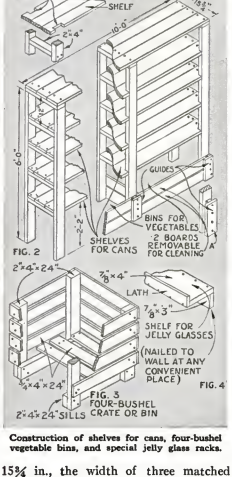
The 2 by 4 in. piece is cut into six pieces 2 ft. long, and three pieces are assembled for each end, as shown, with tenpenny common nails. Four pieces of the ¾-in. material 24 in. long are fastened at each side and end by using sixpenny common nails. A space of 1 in. is left between the boards.

The floor of each bin

consists of five pieces of the ¾-in. material placed on the sills to allow ample air space under the crates. If space is limited, one crate may be placed on another.

Shelves for the storage of cans and fruit are built along the wall of the storage room, opposite the potato crates, as shown in Fig. 2. Bins for vegetables, built under the shelves, are part of the same construction. It is to be understood that the length of the shelving is determined by the length of the available wall space.

The framework is made of 2 by 4 in. material, assembled with sixteenpenny common nails. The depth of the shelf is



Construction of shelves for cans, four-bushel vegetable bins, and special jelly glass racks.

15¾ in., the width of three matched "roofers"—tongued-and-grooved boards.

The framework and shelving should be assembled away from the wall, so that the boards can be slipped in from the end. By using eight posts that are 6 ft. long, shelving 10 ft. long can be supported. By setting the five shelves 12 in. apart, a space of 26 in. is left below the bottom shelf, which gives ample space for vegetable storage bins. Two 15¾ in. long roofers are nailed to the inside uprights at the bottom, making three bins.

The front boards should be removable to facilitate cleaning the bins. A simple way to accomplish this is by making and nailing guides to the fronts of the posts at the bottom as shown at *A*. A 1 by 2 in. piece is nailed to the post and a 1 by 4 in. piece fastened to it at the front, forming a pocket for the boards.

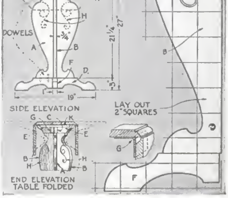
A handy shelf for jelly glasses may be made as indicated in Fig. 4, and nailed to the wall or studding.

How to Make a Drop Leaf Table

Because of its drop leaves, this table requires little space when set against a wall.

THIS table is an exceptional application of the "butterfly" idea, yet lacks the usual obtrusiveness of its type. When closed it is still wide enough to be really useful in a narrow corner. The table may be made of any wood, although the designer had mahogany in mind.

In making the table, the top requires one center piece ¾ by 10 by 24 in., and two leaves ¾ by 7½ by 24 in. The edges may be molded to a hinge joint by hand, which requires suitable molding planes, or it may be taken to a mill. The joint may be made square, if preferred, in which case the center piece should be 10 in. wide and each leaf 7 in. wide. The pedestals consist of: *A* ¾ by 12 by 21¼ in.; 2 pcs. *B* ¾ by 5½ by 21¼ in.; *C* 1 by 2 by 18 in.; *D* 1 by 3 by 20 in.; 2 pcs. *E* 1 by 2 by 8½ in.; 2 pcs. *F* 1 by 3 by 9½ in. They may be sawed by hand



The pedestal pattern is plotted point for point on paper ruled with 2-in. squares.

or taken to the mill with the top and bandsawed.

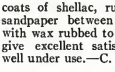
When the marking and sawing have been done, fit pieces *A*, *C*, *D* and *B*, *E*, *F* together with dowels. With a ⅛-in. veining gouge, cut scrolls *H*. Smooth and sandpaper the edges and sides of all pieces and glue the parts together. Fit 1½-in. wide brass hinges at *G* and assemble the pedestal.

Try the top pieces to be sure that they are flush on the top and cut the leaves to the octagonal form shown. Make beveled edge cleats *K* ⅝ by 2 by 7 in. and fasten with ¾-in. No. 8 screws; these will prevent the center piece of the top from splitting. Assemble by fitting 1½-in. brass flap butts. Note the placing of the butt *G* in relation to the joint in the detail of the rule joint.

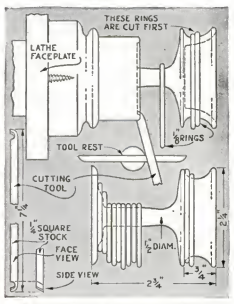
The table may be finished in the natural wood or stained as desired. Three or four coats of shellac, rubbed with No. 4/0 sandpaper between coats and finished with wax rubbed to a velvety sheen will give excellent satisfaction, as it wears well under use.—C. A. KING.

Turning a "Congo Cup"

TO TURN the curious "Congo cup" illustrated, from a single block, would seem a difficult problem; yet anyone who owns a lathe can do it when the principle is understood. The example shown, made by E. T. Armstrong, of Pasadena, Calif., contains twenty-five rings and is considered by him to be the record. He calls it a "Congo cup" because it recalls those African belles who wear rings around their necks. The requirements are a block of thoroughly seasoned pear, apple, orange, or lemon wood, a double-ended tool, and a steady hand. Turn the outside of the bowl of the cup with the two rings which encircle it, before hollowing the inside. Cut the rings halfway through with one end of the tool and finish with the other end. In cutting the rings around the stem, turn the top one first.—H. S.



Twenty-five ring cup and the special tool.



Each finished ring is moved to one side.

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"LITTLE GIANT" No. 311 might easily be called the world's most practical screw plate. For there—compactly packed in one convenient box—are taps and dies to take care of 98% of all the threading jobs the average man or mechanic is ever called upon to do!

Perhaps that's one reason why *"Little Giant"* No. 311 is used more widely than any other screw plate ever offered for sale. Another reason might be that each tap and die in the set bears the *Greenfield* trade mark—a sure sign of precision, long wear, faultless performance.

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A Sturdy Chair for Little Ones

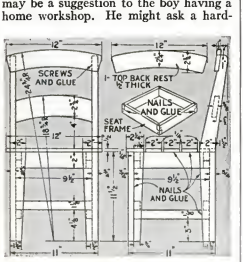
Its strong construction makes this chair especially suited for the hard usage which children give furniture.

AS A project for either the home workshop or the woodworking shop, the child's chair illustrated is at once useful and instructive. The design won second prize in the intermediate woodworking division of a shop problem competition for teachers conducted by the Educational Department of POPULAR SCIENCE MONTHLY.

C. A. Sylvester, who prepared the design, is an instructor in the North Continuation School, Pittsburgh, Pa. In a long and carefully developed instruction sheet which accompanied his drawings, he said:

"The child's chair makes a very attractive project for the junior high school boy or for the boy who has a home workshop. There is an incentive to make it for little brother, or a set of four forms a fine gift for sister to use with her table for her tea parties. It can be worked as an individual problem in the manual training shop, or developed on a productive basis in an industrial shop.

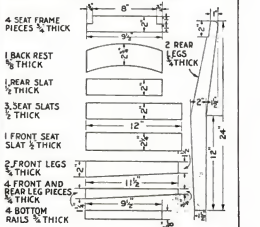
"The writer is now making the chairs in his shop for the Board of Education, to supply seats for the primary rooms of the different public schools. A monetary credit is granted against supplies and materials used, thus reducing the cost per pupil in his department. Further, he is making the chairs from lumber salvaged from large packing boxes supplied by the near-by mercantile establishments. That may be a suggestion to the boy having a home workshop. He might ask a hard-



The joints are held with glue and screws or nails. Note the method of joining frame for the seat.

ware dealer or a dry goods merchant for a box that would be suitable for making the chair."

Since many of the parts are duplicates of others, it is necessary to lay out only one piece of each set accurately; the finished piece will serve as a template for the others. When the chairs are to be made on the production basis, the templates may be made from sheet metal.



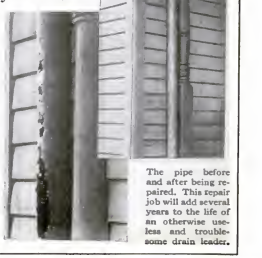
If one piece is laid out accurately it can be used as a template for the others of the same size.

How to Fix a Galvanized Iron Pipe Temporarily

GALVANIZED iron drainpipes and gutters can be temporarily repaired by applying strips of canvas and using ordinary house paint thickened with whiting or plaster for the bonding agent. The drainpipe illustrated is an example of this method. Although seemingly beyond repair, it was effectively covered, and a few years were added to its life.

The pipe is removed, if possible, and a generous coat of the heavy paint applied to it and to one side of the 3 in. wide canvas or cloth strips. The strips then are wound in spiral fashion until the hole or holes are completely covered. After the bonding coat has thoroughly dried, two or three coats of oil paint of the desired color are applied to the entire pipe.

To repair gutters, proceed in the same manner, applying the paint and canvas to the inside of the bad spots.—JESSE RICE.

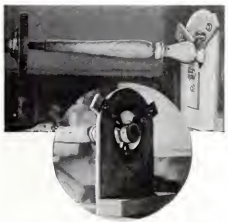


The pipe before and after being repaired. This repair job will add several years to the life of an otherwise useless and troublesome drain leader.

Boring True Sockets in Turned Work

BY USING the simple homemade steady rest illustrated, it is possible to bore holes for the tenons of a three-piece floor lamp standard or similar parts in the lathe with certainty that the joints will be perfectly aligned.

The framework of the steady rest is a piece of plywood, cut as shown and screwed to a block that can be clamped to the lathe bed. The three guides are 1½ in. wide, each being provided with a slot wide enough to take a ⅛-in. machine



The steady rest holds the stock on its true center line and insures a centered hole.

screw. One is placed at the bottom, and the others are spaced at 120° apart.

In preparing the stock to be bored, it is necessary to nail a piece of ¾-in. plywood to the end which is to receive the screw center at the headstock. The purpose of this piece, which is turned down with the stock, is to give a good grip for the screw center so that the stock will not slip during the boring operation.

After the stock has been thus prepared and turned to shape, the steady rest is mounted on the bed, and the tailstock is again brought up and engaged with the dead center. This insures that the work is lined up with the centers, and the guides can be adjusted to suit, snugly but not too tight. A little oil or grease is next applied to the guides to allow smooth turning. The dead center then can be removed and the hole bored with great accuracy.—L. ST. JOHN HELY, M.D.

Indexing Tailstock Spindle

BY MARKING graduations on the tailstock spindle, you can reduce the tediousness of drilling stock to exact depths in the lathe.

If a milling machine is not handy, place the spindle in a lathe chuck and cut a sixteen-to-the-inch thread on the shank. Cut a line the full length of the threads, so that it will be on the top of the spindle, and mark divisions along this line every four threads or ¼ in.

The movable indicator is a pointer with a slot to fit the shank of the tailstock spindle lock bolt. By setting this at zero at the start of each operation, the depth drilled can be noted.—G. S.

How to Perform Five Simple Tricks of Pocket Magic

By George S. Greene

Fig. 1. The red candle cover about to vanish.
Fig. 2. Ring used to move the magic golf ball.

YOU may have been mystified and entertained on various occasions by neat little tricks performed by an amateur magician at the dining table. Perhaps you wondered if you could duplicate them if you knew their secrets. You can. By practicing the following tricks, you will be able to achieve astonishing effects.

The Color Changing Wax Candle. An ordinary colored wax candle is exhibited and lighted. The performer extinguishes it by taking the wick between two fingers—and it instantaneously changes color.

The candle is unprepared, say blue in color. A piece of red silk is placed around it and held with pellets of wax, so that it will appear to be a red candle. The lower end of the silk is fastened to a length of black cord, which passes up the performer's right sleeve and down the left and is tied to the left wrist.

On grasping the wick (Fig. 1) the performer extends his hands, shortening the cord and jerking the red silk up the right sleeve. Presto! the candle is blue and may be passed for examination.

The Traveling Golf Ball. This is a good trick at sport affairs. An unprepared

Fig. 3. How spirit writing is done on a card with a bit of pencil lead fixed to a thimble.

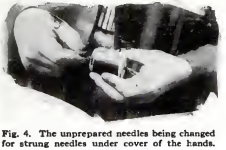


Fig. 4. The unprepared needles being changed for strung needles under cover of the hands.

golf ball, which may be borrowed, is placed in the center of the dining table. The performer makes passes over the ball, and it rolls to him and finally falls.

Underneath the table linen place a small wire ring (Fig. 2), fastened to a cord. When the ball is set on the linen over the ring, a gentle pull on the cord will make it move.

Spirit Writing. A calling or business card is borrowed and held in the performer's right hand. He asks a member of the audience to call a name or someone's initials. When the card is handed back, the name or initials are found written on it in pencil.

The secret is a prepared thimble with a piece of pencil lead fastened to the end (Fig. 3). This is "palmed" in the fleshy part of the hand between the thumb and the first finger. In holding the card as illustrated, it is easy to slip the thimble on the first finger and write the name or initial under cover of the card.

Needle Swallowing. This was a famous Houdini trick. A piece of thread is wound around some loose needles, which are placed in the mouth. Then the performer slowly pulls the thread from his mouth with the needles threaded on it.

In the regular version, a duplicate set of needles is concealed in the mouth beforehand, and there is some danger of

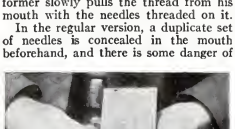


Fig. 5. The message, passing through the slit, is in full view after the envelope is sealed.

swallowing them. A safer yet perfectly effective method is as follows:

The spool of thread has the duplicate set of threaded needles inside it. After breaking off a length of thread and asking a member of the audience to wrap it around some needles selected from a package, the performer retains the spool in his hand. Before setting it down, he reaches for the loose needles and thread and, under cover of his hands, shoves them inside the spool and places the latter on a table. By this apparently natural action, the threaded needles have been pushed out into his palm (Fig. 4), ready for the pseudoswallowing gesticulations and the subsequent production of the needles one by one on the thread.

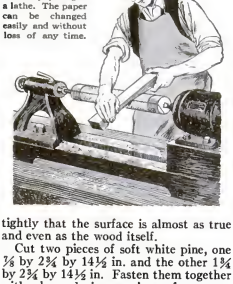
Mind Reading. Spectators have to write questions on cards, which the per-

former seals in small end-opening envelopes—like pay envelopes. He then answers each question, tears open the envelope, and returns the question without looking at it.

A slit has been made on the backs of the envelopes, near the opening. As the cards are placed in each, they pass through the slit so as to be readable from the back. (Fig. 5). A pile of the sealed envelopes can be held in the hand and each answered in its turn. Of course, when the envelope is torn open, the tear is vigorously and apparently carelessly made at the slit so that the evidence of trickery is destroyed.

Lathe Sanding Drum Split to Make Clamping Easier

FOR use in a wood-turning lathe, the drum sander illustrated has two advantages over the ordinary solid type. It makes changing the sandpaper easier and allows the paper to be drawn so tightly that the surface is almost as true and even as the wood itself.



Using a split drum for sandpapering in a lathe. The paper can be changed easily and without loss of any time.

Cut two pieces of soft white pine, one ⅞ by 2¾ by 14½ in. and the other 1¾ by 2¾ by 14½ in. Fasten them together with glue, placing a piece of common wrapping paper between the glued surfaces so that they can be split apart.

Center each end, place the stock in a lathe, and turn it down to 2¾ in. in diameter. Drill a hole near each end to receive a ¼-in. bolt, and counterbore to receive the head and nut. The two portions of the drum can now be separated.

To load the drum, it is necessary only to place the sandpaper as shown, with the two bent-over laps set over the opened edges of the drum. Tightening the bolts then draws the paper taut.

The drum is held in the lathe by the same center holes that were used in turning it.—DICK HUTCHINSON.

How the paper is prepared and placed over the split cylinder before the bolts are inserted.

Spanish treasure galleon model built by Theodore Jansen with the guidance of POPULAR SCIENCE MONTHLY blueprints.

Will It Be Galleon or Clipper Model This Year?

ARE you going to build an historic ship model this season, either as a Christmas gift or just for the fun of it? Certainly no hobby gives more pleasant and satisfactory occupation for the lengthening evenings of fall and the storm-bound nights of winter.

What model to make is a matter of personal preference. There are ten to choose from in the list of ship model blueprints on page 114, not counting the modern fishing Schooner *Bluenose*. These all were designed by Capt. E. Armitage McCann, nationally recognized authority on ship models.

The bell mount and stern deck stairway.

The pirate galley, the Viking ship, the small Baltimore clipper, and the scenic half-model of a barque are relatively simple to build; the others are more elaborate, although all are intended for beginners and have been simplified as much as possible.

The model illustrated is a Spanish galleon constructed by Theodore Jansen, of Newark, N. J. In sending eight photographs of his remarkably well-built model, Mr. Jansen wrote:

"Accept these photographs with my compliments for the wonderful blueprints of ships you have issued (all of which I possess), also

Bow of the galleon. Note arrangement of the cannon, anchor, headboards, and figurehead.

for your very interesting and useful magazine.

"No doubt you have been swamped with other photos of ship models built by your magazine readers, but I thought the inclosed pictures would interest you, as I have elaborated on the ornamental work and also designed a different base, the surface of which is built up like ripples of water, while the sides contain a conventional wave design and the hull itself is supported by two waves on each side.

"I found pressboard such as electricians use, which comes in all thicknesses, very useful for small parts that had to be perforated. It is stronger than wood, yet can be bent almost double before breaking, an advantage on parts that have to be curved.

"The sails are of copper bent to shape, shellacked, and covered with voile. The stitching of the sail surface is, of course, done before applying to the copper.

"I hope to start another model this fall, although I have not decided upon which one."

The blueprints from which Mr. Jansen worked are Nos. 46 and 47. They will be sent to any reader for fifty cents.

Builds Modernistic Cupboard Cheaply

Cupboard made of plain boards but distinguished by modern treatment of book-shelf.

LONG before modern furniture took a place generally on the market, I wanted a cupboard that would be useful, ornamental, and inexpensive.

After the cheapest kind of siding had been obtained, the cupboard was built to fulfill my idea of having two compartments to store material, with doors, and an opening along the top for books. The back was covered with wall board to make the cupboard dustproof.

The wood carried a decorative grain; so a walnut oil stain was used as a finish and rubbed to bring out the figure of the wood, which was then waxed. As the top, a broad shelf, is used for vases, antique brass, and the like, this piece of furniture is quite fitting for a studio or, indeed, for other surroundings.

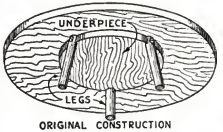
Imagine my surprise and interest, upon picking up a recent book on decorative art, to see a photograph of a cupboard almost identical to mine. Of course, a high grade of wood was used, but I could discern my idea.—CLARA M. LANGSDORF.

Coffee Table Made from Old Taboret

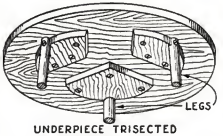
ALMOST any old-fashioned taboret or spindle-legged stand, now reposing peacefully in the attic, can be converted into an attractive coffee table. That shown at the right was redesigned by Mrs. Dorothy Browne, of Monrovia, Calif., from a stand which had been an heirloom.

The converted table looks unlike a taboret.

The main alteration is arranging the legs so that they are more nearly vertical. This is accomplished by removing the piece under the top, trisecting or quartering it, depending on whether the original table has three or four legs, and placing each section farther out from the center of the table, as shown below. The legs are



ORIGINAL CONSTRUCTION



UNDERPIECE TRISECTED AND OPENED OUT

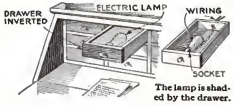
To make the legs more nearly vertical, they are removed and spread apart at the top.

replaced after they have been cut down to a length of 18 in., bringing the top down to the height of the average coffee table.

If the top and legs have many carvings and old-fashioned decorations, remove them, as the modern low table is marked by its simplicity.

Desk Drawer Hides Lamp

BY SCREWING a socket on the inside of a desk drawer, it is possible to provide a convenient lamp without marring



The lamp is shaded by the drawer.

the appearance of an antique desk. For use, the drawer is merely pulled out and inverted.—JOSEPH BRAUNSTEIN.

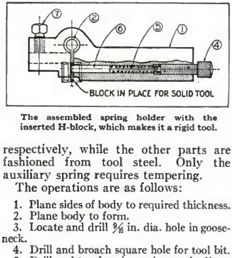
A Spring Tool for Thread Cutting

A SPRING tool for cutting fine, accurate threads on a lathe is a valuable addition to any machinist's or toolmaker's kit and therefore forms an especially good project for high school or vocational school machine shops.

The holder is machined from one piece of stock; it has a spring to supply the tension.

The design illustrated was developed by E. C. Youngbluth and J. F. Faber, instructors at the Academy High School, Erie, Pa. It has several desirable features. The holder can be made from one piece of flat stock and requires no tempering, because an auxiliary spring, which is replaceable, supplies the exact degree of tension needed for any specific job. Furthermore, the holder can be converted into a rigid tool by the insertion of an H-block, if so desired.

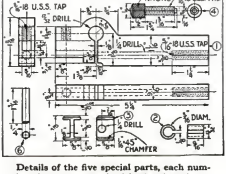
The coil spring and adjusting screw are made from spring steel and machine steel respectively, while the other parts are fashioned from tool steel. Only the auxiliary spring requires tempering.



The assembled spring holder with the inserted H-block, which makes it a rigid tool.

The operations are as follows:

1. Plane sides of body to required thickness.
2. Plane body to form.
3. Locate and drill 9/16 in. dia. hole in gooseneck.
4. Drill and broach square hole for tool bit.
5. Drill and tap for pin, spring, and adjusting screw.
6. Mill slot in gooseneck.
7. Machine auxiliary spring.
8. Harden the auxiliary spring. It should fit the hole in the gooseneck snugly.
9. Make and fit adjusting screw, using a 5/16



Details of the five special parts, each numbered to correspond with the view above.

in.-18 United States Standard thread. Knurl the cap.

10. Form coil spring.
11. File and polish.
12. Assemble.

This project was awarded third place in the advanced metal-working division of a teachers' shop problem competition conducted by the Educational Department of POPULAR SCIENCE MONTHLY.

Footstool from Tin Cans

TIN cans and footstools are never associated, but a serviceable and attractive footstool can be made by using tin cans for the form.

Seven cans are tied as shown. It might be well, however, to cover each can with

The finished footstool is light yet substantial.

How the tin cans are tied together with cord.

cloth to prevent any rattling. A padding of cloth is placed on the top and bottom. The cover can be of velvet, any heavy upholstery fabric, or even a piece of old carpet.—W. E. B.

Hints for Model Makers

TO MAKE steering wheels for my two models of the *Sovereign of the Seas* (POPULAR SCIENCE MONTHLY Blueprints Nos. 51, 52 and 53), I used sheet lead. A ¼-inch hole was drilled in the center of the blank, the rim was sawed on the outside, and six holes were drilled from side to side with a No. 70 drill for the spokes. Pins were used for the axle and spokes and soldered together at the center.

On the baseboard of each model I placed a name plate prepared from a piece of copper. I coated one side of the plate thoroughly with shellac and painted a margin around the edge on the other side. Then I painted on the name with etcher's stopping-out varnish (shellac will do, but plenty must be put on). The plate was etched in a bath of nitric acid.—T. C. MORRIS.

TOOLS that are subjected to dampness can be protected by the following: Melt 1 part rosin in 6 of lard, add benzine in proportion of 1 pt. to ½ lb. lard. Mercurial ointment will also protect steel tools.

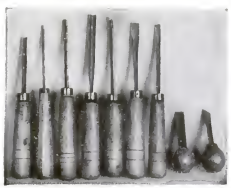


Fig. 1. Set of wood-carving gouges and chisels fashioned from discarded hand hack saw blades.

Wood-Carving Tools Made from Hack Saw Blades

WOOD-CARVING tools, always expensive to buy, can be made without difficulty from old hack saw blades.

One of the most necessary tools in wood carving is the "grounder" or flat gouge shown second from the right in Fig. 1 and in Fig. 2. It can be made from a 3-in. length of hack saw blade. The blade is first softened as described in a previous article, "Tools from Old Hack Saw Blades" (P. S. M., Oct. '29, p. 98). After it has been allowed to cool, the teeth are filed off.

The gouge shape is obtained by setting the vise at the proper width and driving the blade into the opening with a hammer, as shown in Fig. 3 at *A*. Another and more efficient method is to use a wooden swage block cut to fit the shape of the tool as at *B*.

In order to stiffen the otherwise springy blade, the channel must run the length of the tool. The edge of the tool, which has an outside and an inside bevel, the inner one being about one-third as long as the outer bevel, is shaped and partly sharpened before being hardened.

Heat the tool to a dull red for about 1 in. of its length; then, holding it vertically, plunge it into cold water. To temper

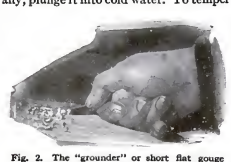


Fig. 2. The "grounder" or short flat gouge can not be purchased yet is most useful.

it, brighten about 1 in. at the point and hold it over the flame so that the tool is heated in about the middle. Watch the cleaned part for the appearance of colors. As soon as a light brown or straw color appears, plunge the tool into the water. Here again the tool should be held vertically while plunging.

Hack saw steel, if treated in this way, will hold a very keen edge. The beginner is apt to soften the metal too much during this tempering process. Should the tool

prove too soft, the hardening and tempering can be repeated.

All of the gouge-shaped tools shown in Fig. 1 are made in the same manner.

When making a flat chisel, the end of the blade is, of course, left flat, but the stem is made trough shape to add to the stiffness of the tool. The cutting edge is

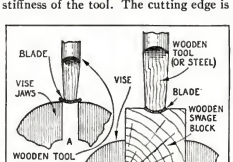


Fig. 3. The blade may be made gouge shape by employing either of the methods illustrated.

formed by two bevels of the same length, each side of the tool having a bevel.

The tools are ground and sharpened in the usual way, preferably using a water-wet grindstone for the grinding. Care must be taken if an emery wheel is used, as it is very easy to remove the temper from these thin tools.

Slip stones with round edges can be obtained in various sizes for sharpening the inside of the gouges. The finish edge is applied by using a leather strop charged with crocus or rouge.

If care is taken in making, shaping, and heat-treating these tools, a fine set of wood-carving chisels and gouges, large enough for almost any work ordinarily undertaken by amateurs, can be made at little expense and with only a moderate amount of effort.—EDWARD THATCHER.

String Aids in Painting Chair Rungs Neatly

WHEN chair rungs, legs, and similar parts of furniture are to be painted or lacquered with decorative bands of color, the work may be simplified by marking the boundaries with a string, tightly tied as shown. The cord prevents

Applying the trim colors after marking their limits with string tied in the desired positions.

the trimming color from running over the foundation color. After the trim is dry and the cord has been removed, an even line is left between the two colors, separating them neatly.

On flat surfaces, paper wrapping tape or specially prepared "masking" tape, which is easily removed, can be used for the same purpose with excellent results. —WALTER E. BURTON.

Repairing Defective Electric Cords

How should the defective cord of an electric lamp or appliance be repaired?

REPAIRING a defective cord is the most frequent electrical job the handy man has to undertake. It is essential to make sure, however, that the cord is really defective. (See "Testing Defective Electric Cords," P. S. M., Oct. '29, p. 141.)

To replace an attachment plug of the separable variety, use a pocket-knife to clean off the insulation on the ends of the two wires in the cord for about ½ in., taking care not to cut off any of the fine copper strands. This can be best done by placing the cord between the knife and thumb (Fig. 1) and using a scraping motion. The practice of carrying the knife around the wire first, as is advocated by some writers, is risky in inexperienced hands, as it is easy to cut off some of the strands.

Fig. 1. Scraping the covering from the cord with a pocketknife.

Twist the strands tightly into a snug cable, tie the underwriters knot as illustrated in Fig. 2, drop the other end of the cord through the hole in the plug, and make a half turn of the wires from left to right under the binding screws. Tighten them and trim off all surplus stray ends of wire with a knife or short scissors.

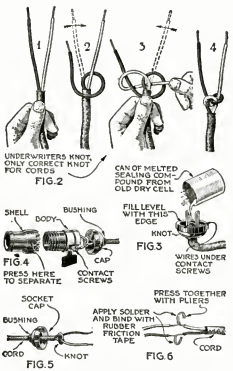
If you wish to make an exceptionally fine job of the replacement and one that will be permanently free from trouble, proceed as follows: Remove some of the sealing compound from the top of an old dry battery and melt it in an old can. When the compound is liquefied, grasp the assembled plug and, holding it level, pour the melted insulation in the center of the plug until the depression is filled even with the edge (Fig. 3). If there is

a little space around the wire for the compound to escape, this may be blocked with a bit of paper before pouring.

How is a broken or defective socket replaced?

REMOVE the old one by pressing on the shell at the point where it is marked "press" (Fig. 4). Separate the shell from the cap to allow access to the contact screws where the wires are attached. Loosen the wires and pull them off. Remove the cap.

Proceed to install the new socket by slipping the new cap over the cord. The cap should be bushed with a composition bushing. Never place directly on a cord any cap which has a rough threaded hole



Underwriters knot (Fig. 2); sealing plugs (Fig. 3); assembling socket (Figs. 4 and 5); joining wires with solder and tape. (Fig. 6).

to cut the insulation. Clean off the ends of the wires, twist tightly, and tie an underwriters knot as well (Fig. 5).

Attach the wires under the screws in the porcelain body, tighten them, and cut the surplus ends off close. Place the brass shell over the porcelain body, taking care the slot lines up with the key or the pull ferrule, as the case may be. Snap the cap on the shell tightly by pressing all around.

How is a connection made to a lamp or appliance with a cord which must have taped joints in the base?

UNWRAP the old tape. If the joint has been soldered, it will have to be cut apart; otherwise, simply untwist the wires and separate.

To replace with new cord, first see that the hole where it enters is properly bushed or is very smooth. Push the cord through and, if space within permits, tie an ordinary knot with the whole cord on the inside to take the pulling strain. Remove about ¾ in. of the insulation, twist each wire tightly with one of the base wires, turn over the end of the joint to make a U and press the U to-

Ⓢ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

gether (Fig. 6). With a hot soldering copper, flux, and wire solder, make the joints permanent. Then thoroughly insulate the joints with a little "rubber" tape stretched quite thin. Follow this with a coating of ordinary tape, taking care to turn this over the ends. A well-made joint is not made as large as possible; it is very tightly wrapped with sufficient material but not an abundance.

What is necessary to replace a plug on the end of an iron, toaster, percolator, or waffle iron cord?

FIRST remove the old plug by taking out the screws that hold the two halves of the composition forms together. Inside will be found two separate contact spring pieces attached to the wires by short screws. Loosen the screws, pull off the pieces, and remove the strain spring.

A new one is put on by reversing the order of removal. Before doing so, see that the insulation on the wires is composed of asbestos, which is the only safe material to use on heating appliances. Also be sure that the wires are well protected with this material right up to the point of attachment. It is considered good practice when making this repair, if the end of the cord is at all worn or otherwise questionable, to cut off about 3 in. This amputation gives a clean new end to work with.

The first operation is to slip the spring strain piece on the cord with the rubber bushing end first. Then clean off the ends of the wires down to the copper for about ¾ in., twisting each into a tight cable. Make the ends fast under the screws on the spring contact pieces and trim off the extra strands.

The halves of the composition body of the plug are now ready to be clamped on the assembly. Take care to arrange the wires in the grooves molded in the inside of each half to take the strain without a knot. It will be found that the outer braid will have to be trimmed back about 2 in. When the halves fit together properly and the end of the strain spring is placed in the groove provided for that piece, the screws can be tightened and the job is finished.

What are the best types of cord to use in making these replacements?

SILK covered cords generally are thinly insulated and should be used only for connecting lamps in dry rooms.

For vacuum cleaners, washing machines, and other appliances where cords are subject to severe wear, use heavy, round black cord, cotton-covered outside and rubber-covered inside. Electric irons, percolators, grills, toasters, and all other appliances using electricity for heat, usually require asbestos-insulated cord.

In the garage, for long portable lamps or tools, use all rubber or steel armored cord, as grease, water, gasoline, and hard wear are encountered.

Never tack or nail a cord around a baseboard, or you may cause a fire. Cords are supposed to be strictly portable. Allow the cord to lie on the floor if it is absolutely necessary for it to run a short distance.—Harold P. Strand.

Water Tube Heater Improves Furnace

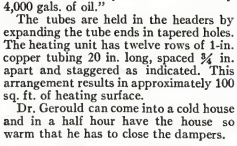
The water tube unit installed in a secondhand cast-iron boiler. Note the stagger of tube rows.

DISSATISFIED with the cost and difficulty of heating his twelve-room house with a large sectional hot water heater of standard design, Dr. J. B. Gerould, of North Attleborough, Mass., bought a small secondhand cast-iron boiler and replaced the heating sections with two headers and twelve rows of staggered 1-in. copper tubes.

"My whole idea in remodeling the boiler," he writes, "was to get quick heat, but with it I also get great economy. I have never burned more than eleven tons of coal a year since I made the change in 1902, and during the last three years, since I have had an oil burner, my oil consumption has been a little less than 2,000 gals. A neighbor with a house approximately the same size as mine burned 24 tons a year and now nearly 4,000 gals. of oil."

The tubes are held in the headers by expanding the tube ends in tapered holes. The heating unit has twelve rows of 1-in. copper tubing 20 in. long, spaced ¾ in. apart and staggered as indicated. This arrangement results in approximately 100 sq. ft. of heating surface.

Dr. Gerould can come into a cold house and in a half hour have the house so warm that he has to close the dampers.



The copper tubes are held in place by expanding the ends in the tapered holes in the headers.

Proper Undercoats Insure Success in Painting

By Berton Elliot

The question of what undercoat to apply for some specific painting job is one that generally bothers the amateur painter, but the selection of the proper priming coat is little more than following a few common sense rules.

For all general purposes undercoats can be divided into four classes: for use under enamel, varnish, lacquer, and flat wall paint.

In enameling, the procedure is to build up a foundation of flat undercoats before the final finishing coat or coats of full enamel is applied. The process is substantially the same regardless of the surfaces being finished. However, where new woods of the open-grain type are to be finished, the pores should be filled with paste filler. This also should be done on previously finished open-grain woods from which the old coatings have been removed with paint and varnish remover.

Painting is more than spreading paint; much depends upon the choice of undercoats.

The material generally used for enamel undercoats is a prepared "enamel undercoater," sold at most paint stores for the purpose. White lead and oil paint is also used, but the home craftsman usually avoids mixing his own paint. Flat wall paint also makes a good enamel undercoat. While it is softer than the specially prepared undercoaters and therefore does not make quite so hard and firm a foundation, it has the advantage of coming in a variety of colors.

The prepared undercoaters generally come in white only and are adapted for use under white enamel and the light tints of ivory, cream, and gray. The amateur painter will find it better, when enameling in stronger and brighter colors, to use flat wall paint of a color closely approximating the enamel finish. Any skipped or too thinly spread-out places will not be so apparent when there is not so great a contrast between the undercoating and the finishing coats.

The surface should be rubbed down with fine sandpaper (No. 00) to platelike

smoothness before the first coat, and lightly between coats, to remove brush marks and level off nibs, bits of grit, and dust. The loose particles must be dusted off thoroughly.

Just a word about the application of enamel undercoats. A three-coat job is generally used for white and the light tints, as follows: first coat, flat undercoater; second coat, a mixture of equal parts of flat undercoater and enamel; third coat, full enamel.

Yellow pine, cedar, cypress, and similar pitchy, resinous, or oily woods, should be sealed over with a coat or two of thinned shellac before starting to build up the enamel foundation, as it prevents the pitch or oily substance from coming through and discoloring the finish.

In the refinishing of mahogany and other dark, stain-finished, woods with light colored enamels, a sealing coat of shellac should be applied before the first undercoats; this will prevent the stain from bleeding through in the majority of cases. It is, however, almost impossible to apply a light enamel finish satisfactorily over some types of penetrating red mahogany and cherry stains.

THE most practical way to build up a varnish foundation, especially for the home finisher, is to apply as many coats of varnish as necessary over a foundation provided by the use of paste filler, if the wood is of the open-grain type.

The filler, which ordinarily comes in paste form either in a light or "natural" color, or stained dark, is reduced with benzine or turpentine to about the consistency of heavy cream, and is applied to the surface with a brush. After standing a few minutes until it commences to set—this is indicated by a dulling out or loss of gloss—it should be vigorously wiped off with a cloth, across the grain. Care should be taken that every bit of the filler is removed except that which has entered the pores. Allow the work to stand for at least twenty-four hours, until the filler in the pores has dried. The surface is now ready for the finishing coats of varnish.

Liquid fillers are used to some extent on close-grain woods, where paste filler cannot be forced into the pores. Although it is a general practice in the varnish finishing of interior woodwork and floors of close-grain woods to start applying the varnish directly over the wood without any undercoat material of any kind, a liquid filler may be employed to advantage on furniture and other surfaces where the finest finish is desired.

Some finishers also apply a coat of liquid filler to open-grain woods after the paste filler has dried throughly hard, to fill the tiny wood cells that are not filled by the paste filler, thus giving an absolutely smooth surface and permitting a finish of mirrorlike appearance. Liquid filler is applied with a brush and after it is thoroughly dry is rubbed down close to the wood with fine sandpaper or steel wool.

A brushing lacquer, which dries a few minutes after application, is somewhat different from other finishing

materials. It is reasonably satisfactory without undercoats. In the first place, though it does not have any wood-filling properties to speak of, its makeup is such that it seals over the surface, very much as shellac, instead of soaking into it as do painting materials made with oil and turpentine. Therefore it will stand out on the surface fairly well without the use of an undercoating. It also has better hiding power than the transparent enamels; hence, surface discolorations are usually hidden and a solid covering finish obtained with two coats of lacquer without the use of undercoats.

For the finest possible lacquer finish on new work, however, open-grain woods should be filled with paste filler (as previously described for varnish undercoats). Close-grain woods also may be brought to a better finish if liquid filler is employed to fill the small pores.

A PRACTICE favored by many is to apply a wash coat of thinned shellac (regular four-pound cut shellac reduced with about an equal part of denatured alcohol) as a primary coat. Since lacquer can be applied perfectly over shellac, this method may be regarded as good general practice for the amateur finisher. Of course, the advantage of this sealer coat is much greater in the case of the softer woods, and with the extremely soft woods the use of shellac is almost necessary for satisfactory results, unless several extra coats of lacquer are applied.

The use of shellac as a first coater in refinishing old painted, varnished, enameled, and stained surfaces with brushing lacquer also renders the use of the lacquer more satisfactory.

Prepared undercoaters for use under lacquer are sold by some manufacturers. They combine the qualities of a sealer with a higher solid content than the lacquer itself, thus adding fullness and richness to the finish. These should be used according to the directions accompanying the particular make of undercoater that is being used.

In conclusion, a word should be said about undercoats on interior walls. It is absolutely necessary that bare plaster walls which have never been previously painted be given a sizing coat to seal over the extremely porous plaster. If this is not done, an indefinite number of coats could be applied to the surface, soaking in as fast as applied, without producing a satisfactory finish.

Regular wall size or varnish size (sold at all paint stores), mixed with equal parts of the wall paint being used for the work, is extensively employed for the sizing coat. Prepared wall primers also are now available in most localities; in these the size is already incorporated, making a very convenient form of material to use. Either type of material is thoroughly satisfactory.

A GALVANIZED iron roof or building that has been in the open for some time can be painted with any of the standard red lead, blue lead, natural graphite, or iron oxide primers without any preliminary preparation other than seeing that the metal surface is clean and free from grease. After the priming coat, any good oil paint can be applied.

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

THE cleanliness of work and hands necessary to all good craftsmanship demands that the old style begrimed cloth towel should be discarded in favor of a soft, clean paper towel, which is an efficient absorbent not only for water but also for grease and oil.

Unfortunately, the many thoroughly worthless grades on the market have given paper toweling a worse name than it deserves. Here is a simple and dependable test by which the purchaser can judge accurately for himself the real value of the brand of towel that he is using. This is the "water absorbency test," as described by United States Government official specifications for paper towels.

Rest the towel in a horizontal position across a small bowl or other support in such a way that an area of several square inches of paper is free and clear. With a medicine dropper, let fall in the same spot on the paper just two drops of cold tap water, equivalent to 0.1 cubic centimeter. Hold the tip of the dropper near the paper so as not to spread the drops as they fall.

Noting the time that it takes 0.1 cc. of cold water to be absorbed by the paper toweling.

Note the time, to the second, that is required for the complete absorption of the water by the fibers of the paper. Determine the point by stationing the eye above and a little to one side of the towel. As long as any water remains unabsorbed, the reflection of light from its surface will show a brilliant spot, but this will become dull at the moment that the water is entirely absorbed.

Repeat the experiment ten times and average the results. The official test requires that paper toweling completely absorb this amount of water in a maximum of three minutes.

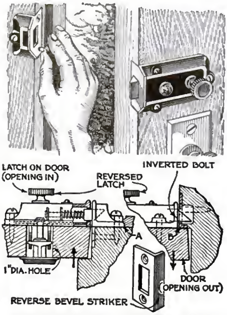
The best grades of towels will absorb even more rapidly than this. On the other hand, the author has tested samples which took between ten and fifteen minutes for the test. Naturally, toweling of this kind could have little or no absorbing power.—W. H. Hammond.

How to Fit a Night Latch Expertly

By DAVID WEBSTER

MANY home workers have fitted night latches successfully, but others have not been so fortunate in their attempts. A few suggestions which do not usually appear in the printed instructions accompanying the locks may be of help in simplifying the work.

We shall consider first the fitting of a rim spring latch of the standard type in the usual way for a right- or left-hand door. Locate the desired height of the latch, about 3 ft. 6 in. from the floor but somewhat less if the approach is from a porch floor that is lower than the floor of the house. If the distance from the center of the cylinder to the edge of the door is supposed to be 2 in., it is well to mark it actually 2 1/16 in., so as to set the latch back 1/16 in.; this allowance is for



The latch can be fitted in two ways, depending on whether the door is one opening in or out.

planing, should the door stick at any time. Bore a 1-in. hole entirely through the door stile.

Break the connecting bar and the screws as indicated on them to suit the thickness of the door. Slip the cylinder through the outside ring until the back of the face is seated. Insert the cylinder from the outside of the door with the keyhole down. Place the false cap or perforated plate on the lock side with the screw holes above the center. Drive home the two connecting screws that fasten the false cap, the cylinder, and the face ring firmly in place. Locate the latch accurately and drive the screws holding it in place on the door.

To apply the striker—the member which is engaged by the latch—it may be necessary in certain cases to cut into the door casing as at *A*, as well as into the edge of the door jamb.

In fitting a night latch on a door opening out, the lock must be set back far enough from the edge of the door to clear the corner of the rabbet at *B*. We shall

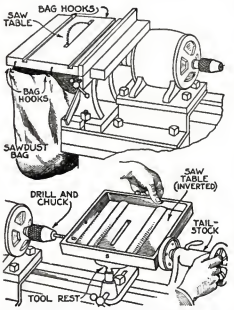
assume that the rabbet is ½ in., which, in the case of a close-fitting door, will require that the cylinder center should be set back about 2⅜ in. This must be verified in every case. Bore the 1-in. hole, remove the backplate of the latch, reverse the latch itself, replace the backplate, and proceed as previously described.

A reverse bevel striker must be fitted to the rabbet so that the latch will engage. The striker should be set in a notch cut into the jamb to receive it as illustrated.

Catching Sawdust from a Small Circular Saw

EVERY owner of a small combination woodworking machine will be interested in the device illustrated, which is designed to catch the sawdust from the circular saw and prevent it from being scattered about the room and over the clothes of the operator.

My circular saw has a sawdust chute which serves a double purpose—to guard the blade under the saw table and to catch and discharge the sawdust in one direction. I have slipped a sugar bag



The sawdust bag in place (upper view); and how the holes for the hooks are drilled.

lining under this chute and have fastened it to the sides of the saw table with four S-hooks.

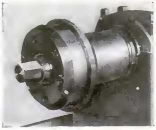
The S-hooks hang in holes drilled in the sides of the saw table. How I drilled these holes is also illustrated. The tool rest was adjusted to support the saw table at the right height and the work fed to the drill by means of the faceplate mounted on the threaded spindle of the tailstock.

A revolving circular saw causes considerable wind, and it is this air in motion which whirls the sawdust about the room. A sugar bag lining acts like a vacuum cleaner bag, for it allows the air to escape but catches the dust. In arranging a bag about a saw that is not shielded under the table, there may be some danger of the bag's becoming entangled in the whirling saw. This should be carefully guarded against.—JOSEPH J. LUKOWITZ.

Chuck for Machining Commutator Rings

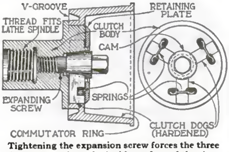
THE commutator rings used on the armatures of New York electric railway (subway) cars are made of cast steel and are machined all over. To insure the balance, the rings must be machined in such a manner that an equal displacement of metal exists at all the opposing points of curvature. It is essential also that parallel faces be produced. The work must be highly accurate.

We found that doing all the necessary work in the dog chuck was quite expensive in time and labor, since it was almost impossible to get the balance desired under test, even with tedious "truing." A mandrel was tried. It gave better satisfaction, but, because of the awkwardness of the tooling, more time was required.



By its aid commutator rings can be turned with a high degree of ease and accuracy.

The problem was finally solved by the chuck illustrated. The body is a forging made from a piece of an old axle. One end is threaded to fit the spindle of the lathe, and the other is provided with a flange against which the ring rests while being machined, and with a cylindrical portion that is a neat fit for the finished bore of the ring. This bore is 7¼ in. in diameter. In the center of the chuck a tapered and threaded hole is machined, in which an expanding screw is fitted. In the body of the chuck three grooves, 1 in. wide and 1½ in. deep, are milled 120° apart and radiating from the center. In these, three hardened and ground dogs are placed. One end of each of the dogs is made to fit the contour of the taper on the expanding screw and is kept always in contact with this screw by the springs.



Tightening the expansion screw forces the three dogs out against the inside surface of the ring.

In operation, the commutator rings are first bored by being held in the regular chuck of the lathe to the exact size required; then they are placed on this chuck, the expanding screw is set up hard, and all the other surfaces turned, bored, and finished at the one setting.

The shank of the chuck is long enough to allow the rings to be reversed so that the V-shaped groove at the rear may be machined.—Albert M. Thomas.

 See page 8.

Are You Caught Behind the Bars of a "Small-Time" Job?

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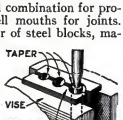
Punch and Die Set for Bellmouthing Tubing

AUTO repair men and other mechanics who make many repairs or new installations in brass or copper tubing will find the little punch and die set illustrated a handy and useful combination for producing uniform bell mouths for joints. It consists of a pair of steel blocks, machined as shown, and a taper punch.

The blocks are made with a step on the side to prevent their slipping down when clamped in the vise. The holes in the blocks are drilled to fit the outside diameter of the tube and are countersunk to a depth of ¼ in., at any angle desired. Other sizes may be provided for in the one set by making the blocks correspondingly larger.



The die, with the tube in place, is held firmly between the jaws of a heavy vise.

The space between the blocks should be from ⅛ to 1/16 in. when holding the tube. In use, the blocks are placed over the tube so that about ⅛ in. of the tubing projects, and are gripped with light pressure in the bench vise. The taper punch is inserted in the tube and tapped down with a hammer.—H. L. WHEELER.

A Wrench for Lock Nuts

WHEN a number of screws have to be assembled with lock nuts, much time can be saved by using a combination screw-driver wrench like that shown. It is then not necessary to run the nuts on the screws first and back them again to the locking position. Another advantage is that the wrench acts as a guide for the screw driver.

The wrench is made of flat bar stock bent as shown, drilled to fit the screw shank, and filed hexagonally to fit the lock nut. The wrench is assembled on the screw-driver before the blade of the latter is flattened, so that the two pieces cannot come apart.

In operation, the lock nut is run on the end of the screw just enough to clear the end so that it can be started in the hole by hand. Then the wrench is slipped over the nut and held in the left hand while the right is used to turn the screw. As soon as the screw is in, a turn of the wrench will lock the nut tightly.—A. KENDALL.

A special combination screw driver and wrench that speeds up the assembling of lock nuts and screws.

WHEN machining heavy work on lathe centers, a wooden brace between the tailstock and the web of the bed may be employed. Back lash can be prevented by inserting a wooden wedge lightly between the faceplate and the lathe ways. The wedge serves only to steady the spindle.

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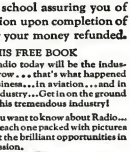

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Back of the Month's News

(*Continued from page 55*)

has importance in medical diagnosis, for it tells the experienced physician something about the state of the arteries through which the blood is flowing, and about the living heart pump that keeps it on the move.

Safer Refrigerators

IN CHICAGO, a few weeks ago, certain mysterious deaths were traced by physicians to poisoning by gases from leaky refrigerators. Immediate results were public suspicion of all mechanical household refrigeration; the appointment of investigating committees by the local authorities, the American Medical Association, and the United States Government; and serious business difficulties of several refrigerator companies.

Three chemical compounds are commonly used in small, sealed refrigerator systems. Ammonia gas is the one used in larger plants for many years. Another, used only in the new small units, is sulphur dioxide, the gas given off by burning sulphur. The third is methyl chloride, occasionally used by dentists and physicians as an anesthetic, but not otherwise known outside chemical laboratories until the new idea of refrigeration was developed. All three chemicals have the property of changing readily from liquid to gaseous form. At one temperature and pressure they are liquids; at another combination of conditions, not very different from the first, they are gases. That is why they are useful in refrigerators, for the working of these devices requires that a liquid should evaporate in one part of the sytem to absorb heat and condense in another part to get rid of that heat.

The cases of poisoning recently identified have been due to methyl chloride. When this compound escapes from a leaky refrigerator unit it does not announce its presence by a strong, suffocating odor, as do sulphur dioxide or ammonia. Methyl chloride gas in the air is odorless, tasteless, inflammable. Inside the human body, however, it undergoes a dangerous chemical transformation. It is converted into hydrochloric acid, which combines with alkali salts in the blood, and into wood alcohol.

THE wood alcohol apparently works the damage. Unlike ordinary grain alcohol this compound is not decomposed and eliminated by the body. Instead, it seems to combine in some manner with the cells of brain and nerves, producing symptoms of mental disturbance and blindness. The small doses of wood alcohol acquired by a person who breathes a little methyl chloride from a leaky refrigerator act similarly. They produce nervous excitement, mental disturbance, ultimate death.

Government experts, after recent investigations have found that most of the poisoning attributed to methyl chloride has occurred in connection with multiple refrigeration systems installed in apartment houses, where a single compressor delivers the refrigerant through tubes to separate refrigerators in the various apartments.

Two procedures are advocated for eliminating the danger. One is the complete abandonment of methyl chloride and all similar compounds. The other is the addition to the methyl chloride of some odorous material which will be smelled at once, so that leaks are detected promptly. Sulphur dioxide and ammonia, although they, too, are poisonous if breathed for a long time, are immediately perceived by the suffocating feeling in throat and nose. Thus they probably constitute no great household danger. Fortunately, most of the household refrigerators now sold use one of these relatively safe gases instead of the more dangerous methyl chloride.

Science Takes Stock of Human Machines

(Continued from page 29)

lightning flashes that may last only a millionth of a second. They had recalled that the impulses along nerves have been known to affect very sensitive electrical instruments. Amplifying the nerve impulses 1,000 times, they succeeded in making them visible as a wavering point of light with the lightning recorder.

Recent discoveries are furnishing other important clues to the mystery of how the nerves' messages are telegraphed. Actually the nerves "get hot" while carrying a message, said Prof. A. V. Hill, of London University, England. It has even been possible to measure accurately the amount of heat they give off.

Why some persons' legs jump at a blow on the knee and others' do not is now explained through a better understanding of the nerves' action, declared Prof. Genichi Kato, of Keio University, Tokio. Contrary to popular opinion, there is nothing necessarily wrong with persons who do not have this familiar reflex, he said. Actually the knee blow may sometimes give a strong nerve response without making the muscle jerk. The explanation he suggested is that a strong succession of nerve impulses may overrun and blot each other out.

Mercury injected into the body is a dangerous stimulant to overworked nerves, said Dr. William Salant, of the Cold Spring Harbor, N. Y., Biological Station of the Carnegie Institution. In experiments with cats, a small dose of mercury salts increased remarkably the sensitiveness of important nerves controlling internal organs, as tested by a mild electric shock. This, he said, accounted for the peril of mercury poisoning.

What to Eat and Why

WHAT would happen to a man who ate nothing but meat? He would thrive on it, reported Dr. E. E. Dubois, of New York, medical director of the Russell Sage Institute of Pathology, after observations of an all-meat diet experiment recently concluded by two Arctic explorers. For more than a year, he said, Vjlhjalmur Stefansson and his fellow-explorer, Karsten Andersen, dined solely upon meat, meanwhile living a sedentary life in New York City under the observation of physiologists. For beverages they subsisted upon meat broths, black tea, and water. During the first weeks of the experiment the men each lost nearly seven pounds, but after that their weight remained constant. None of the expected trouble, such as increased blood pressure, kidney disturbance, or disease from lack of vitamins, developed. The men enjoyed the best of health.

How meat affects growing children was shown in a study of eight youngsters made by Dr. C. C. Wang, Bernice Huddlestun, and Irving Graef, of the University of Chicago. The children, of ages from four to twelve years, were first fed on a diet containing a limited amount of protein or meat element and later on a diet with double the amount. Investigation showed that their rate of growth during the second period more than doubled.

Synthetic "milk" for babies can now be made from vegetables, Dr. Ernst Tso, of Peking, China, reported. Scarcity of cows in China was responsible for the discovery that a milky liquid made of finely ground soy beans and water furnishes an excellent milk. Six infants fed on this liquid, together with other nutritive and vitamin-containing substances, showed normal mental, muscular, and weight development.

Green vegetables are needed to make red blood, declared Dr. A. Zih, of Debrecen, Hungary. Even a plentiful supply of the vitamins supposed to be indispensable in blood-making is useless without fresh vegetables in the diet, he (Continued on page 144)

Science Takes Stock of Human Machines

(*Continued from page 143*)

found after tests upon rabbits. By isolating some of the chlorophyll, the green coloring matter in plants, and feeding it to the animals, he said he had shown that this green color itself contained the concentrated element needed in blood-forming.

Yeast helps digest food, Dr. Wendell H. Griffith, of St. Louis, Mo., reported, following experiments in feeding dried yeast to rats. It had no effect upon appetite, although another substance, a liquid extract of liver, had a marked stimulating effect.

Coffee's sins and virtues were discussed in what is said to be the most comprehensive study ever made of the subject, reported by Dr. Philip B. Hawk, president of the Food Research Laboratories of New York. It showed, he said, that normal young men unused to coffee were likely to suffer sleeplessness, inability to concentrate, tremors and nervousness, and to a lesser degree headaches and dizziness, as a result of drinking two to six cups daily for any length of time. However, coffee did not seem to affect the heart, nor cause any other organic disease. Habitual users of coffee were somewhat less susceptible to an increase in their coffee diet.

Drugs and Their Effects

"HEARTS prefer alcohol" was the dictum of Dr. L. D. Seager and Prof. W. E. Burge, of the University of Illinois, following experiments in which turtle hearts, still alive after removal, were allowed to select their own diet. The hearts were fed a "synthetic blood" containing several forms of nourishment. One group received only "aminoids" and "amino-acids," substances known to chemists as the building-stones of proteins. Some also received alcohol mixed with these substances. The second group had only straight alcohol. The last used up all of the alcohol, while the group receiving mixed nutrition selected the alcohol and rejected the rest. A hasty conclusion would be that alcohol is the best fuel for the human body. But other experimenters showed that the effect on the body as a whole must also be taken into account, and described more practical tests of this kind.

Motion pictures of unsteady rats staggering home after "wild parties" with alcohol and other drugs were exhibited by Dr. Walter R. Miles, of Stanford University, to back up his statement that no drug yet tried improves a body's complete performance above normal. He made the tests by training rats for a month to find their way to food by running through a complicated labyrinth; and then dosing them with various drugs before their journey. Alcohol made the rats turn unsteadily, though they could still remember where they were and where they wanted to go, showing that memory was not affected. A powerful drug named hyoscine, a depressant sometimes used for insomnia, had the opposite effect. The rats could walk perfectly, but they were as uncertain of where to go as if they were exploring the labyrinth for the first time.

The seemingly unimportant presence of water here or there through the body may spell the difference between a normal person and a morphine addict, according to Dr. H. G. Barbour, who reported the findings of a number of Louisville physicians. His redistribution between internal and surface tissues, they find, is the direct result of morphine addiction.

Snake venoms and poisons of ants, toads, and bees are to be tested for their effect on plants, reported Dr. David I. Macht, of Johns Hopkins University. He has found that plant seedlings serve as living laboratories where the effect of animal poisons, to which plants are peculiarly sensitive,

(*Continued on page 146*)

Science Takes Stock of Human Machines

(Continued from page 144)

may be tried out. Application of this method has already been made in testing the blood of anemia patients, as described elsewhere on these pages.

The New Anesthetics

CYCLOPROPANE, a new anesthetic gas, offers unusual comfort to patients about to undergo an operation. They succumb quickly, without struggling; and recovery is also rapid, with no after effects, according to Dr. G. H. W. Lucas, of Philadelphia, and Dr. V. E. Henderson, of Toronto, who discovered and reported the gas. It is a compound of carbon and hydrogen, similar in its effects to nitrous oxide or "laughing gas," except that it is said to be more satisfactory.

A novel form of anesthesia, drugless and painless, was described by Drs. A. and B. Chauchard, of Paris, who said that it awaits further perfection before tests with human beings. It consists of numbing a small area of skin on the head with local anesthetic, making a small opening in the skull, and inserting a small sponge which creates total anesthesia by its gentle pressure. The whole procedure requires only four or five minutes, an electric needle being used for the trepanning operation.

"Electric sleep" is a novelty which has thus far been tried only on animals. Cats can be put to sleep artificially, Dr. W. R. Hess of Zurich, Switzerland, announced, by the application of a low, frequency electric current to the brain. A tiny electrode, the size of a minute needle, is introduced into the deep layer of the brain and the mild current applied. The resulting sleep lasts three or four hours, and on awakening the animals suffer no ill effects.

Marvels of the Microscope

INVISIBLE or "black" light now reveals hitherto unseen wonders through the microscope. Organisms "entirely missing in microscopic examinations by the eye" are now disclosed, according to Ivan Bertrand and L. Justin-Besancon, of Paris, by infra-red rays, which are a form of radiation midway between light and heat. Since the rays are invisible to the human eye, the cells under the microscope are photographed with a camera, on plates especially sensitized to the rays. The peculiar character of the light enables it to penetrate outer portions of living cells until now never revealed.

Ultra-violet "rays," another form of invisible light, play an important part in the microscopic studies of Drs. P. Ellinger and A. Hirt, of Heidelberg University, Germany. They are made visible by staining living cells with a certain dye, fluorescein, which glows when the rays strike it. Cells thus observed in the dark, by the ultra-violet light, stand out in startling relief.

Other wizards of the microscope have used ordinary light to novel advantage. Dr. Eliot Clark, of the University of Pennsylvania, and his collaborator, J. C. Sandison, told of watching cells grow in a living rabbit's ear in which a transparent window had been grafted to replace the outer light-obstructing skin. The rabbit posed conveniently beside the microscope, although a tadpole with its tail under observation proved a more elusive subject. Another remarkable microscope study was that of Dr. W. Cramer, of London, who by darkening adrenal glands with the vapor of osmic acid made their action visible under the lenses. These two small but important organs, located just above the kidneys, have a mysterious effect on human beings, and their mechanism has been little understood. For instance, Dr. Ulf von Euler, of Stockholm, Sweden, pointed out it is impossible to cause fever in an animal which has lost its adrenal glands.

Rays—The Clue to Evolution

(Continued from page 21)

organs and cause illness. At last, if the growing cancer is not removed, the wild cells invade some necessary structure of the body and cause death. When the surgeon removes a cancer he is careful to get out every single cancer cell. If even one is left it will grow, multiply, and cause another cancer.

This necessity of complete removal is one reason why some cancers always have been incurable by surgery. They involve, perhaps, blood vessels that are too important to touch or internal organs that cannot be spared. Formerly such unfortunate patients were beyond aid. Now many of them are saved by the rays from radium.

These potent rays, shot by the atoms of radium as they explode, seriously affect all living cells. If a piece of pure radium should be held in the fingers for a few hours, the skin and muscles would be killed as though burned by fire. People have even died from radium burns. But this killing effect is precisely what the physician wants when he is treating cancer, especially since the wild cancer cells seem to die under the rays more readily than do normal cells. In the modern treatment of cancer by radium, tiny needles containing radium or some other radioactive element are placed in or around the cancerous growth.

About the biological effects of the cosmic rays, more penetrating and probably more potent than the rays from radium, it is not yet possible to be very sure. Cosmic rays have not been produced on earth. They pour continually upon the earth from outer space. Where they come from no one knows, although Dr. Millikan suspects an origin in certain atomic changes taking place in the space between the stars. Every inhabitant of the earth's surface is exposed to them continually. What they do to living matter, or what would happen to human beings without them, no one can say, for no person has ever been without them.

Professor Joly suggests that perhaps the absence of cosmic rays might be harmful to mankind. All three forms of the very short waves probably possess, he says, an ability to kill cancer cells more readily than they kill healthy cells. It might be possible, theoretically, to let beams of these rays shine through a living body with intensities just great enough to kill off any stray cancer cells, but too weak to damage normal cells. Perhaps, Professor Joly adds, that is precisely what Nature is doing to the earth's inhabitants by a continual mild bath of the cosmic rays. Perhaps that keeps cancer in check, so that only a comparatively few people die of that disease instead of everybody succumbing.

What is more, Professor Joly imagines that variations in this bath of cosmic rays in the past may have caused changes in the average amount of cancer. The intensity of the cosmic radiation may not be the same everywhere in the universe. The solar system moves rapidly in space. Perhaps in some spots along its past path through the stars the intensity of the cosmic rays was greater than now, in other spots weaker.

Health experts agree that cancer is increasing in the world. Many possible causes have been advanced for this: richer foods, city life, too much luxury of civilization, and others. Perhaps, Professor Joly suggests, the real cause may be that the earth is now passing out of a space region of relatively intense cosmic rays and into one poorer in these cancer repellents.

If that is true, universal cancer might conceivably be the doom of the human race. But that would be no justifiable prediction, for even if Professor (Continued on page 147)

Rays—The Clue to Evolution

(Continued from page 146)

Joly's suggestions are true in every detail, knowledge of these facts would enable human inventors, doubtless, to devise radium or X-ray substitutes for the decreasing cosmic radiation and to continue checking cancer by artificial means.

The suggestion of Professor Dixon, the other Dublin scientist, that this same variation of cosmic rays in the past may have affected evolution, is even more interesting to biologists. The evolution of life has never run an even course. There is reason to believe, for example, that for hundreds of millions of years after life first appeared its evolution was extremely slow. Suddenly there came a time, just before what geologists call the Cambrian Period, when evolution seems to have taken a sudden spurt. Thousands of new kinds of creatures appeared. Then followed another time of relatively slow evolution, to be succeeded by a second spurt, and so on.

THE new theories suggest that the signal for these variations may have been changes from age to age in the intensity of cosmic rays. If it is true that these rays are plentiful in some parts of space and sparse in others, the earth in past geologic ages may have passed through repeated "belts" of intense cosmic radiation separated by regions of few rays or none. These belts would correspond to the time of rapid evolution.

The record of life's evolution read from the rocks displays also another kind of variation, a variation from place to place. Certain spots on earth seem to have been special centers of evolution. There was a time, for example, when the primitive mammals, forerunners of man and of nearly all modern animals, seem to have evolved with enormous rapidity in lands like Siberia and northern Canada, making a partial belt around the North Pole. On the other hand, there are regions, like Australia, where almost no evolution seems to have happened for millions of years. Descendants of the dinosaurs still exist among Australian lizards. Nearly all of the higher animals of that continent, before its discovery by the white race, belonged to the ancient, little evolved group of the pouch-mammals or marsupials, including the kangaroos and many other creatures represented elsewhere in the world only by a few ancient evolutionary relics, like the opossum.

THE new radiation theories offer the explanation that these geographical variations result from variations in the natural radioactivity of rocks and soils from place to place. In the spot already mentioned, underneath San Francisco, the rocks are more highly radioactive than the average. In Russia, Dr. L. N. Bogojavlensky finds that the natural radioactivity varies in different parts of the country. Dr. Charles S. Piggott of the Geophysical Laboratory of the Carnegie Institution of Washington also has proved that rocks from different places differ in natural radioactivity. In Japan, Dr. K. Shiratori has found widely varying amounts of radioactivity in waters of different hot springs.

It is natural to imagine, then, that the spots of intense radioactivity may have been the places of intense evolution, while spots where there is relatively little natural radium may have been where evolution has lagged.

Amid these new wide-spreading vistas of space, time, and evolution, the biologist of 1930 stands, like Balboa on his peak at Panama, before a new, uncharted, even an unsuspected, ocean of fact. The motive power of evolution seems to have disclosed itself. If Professor Joly and Professor Dixon are right about the cosmic rays, it is a motive power whose sources lie among the stars.

Three Men to Hook One Fish

(Continued from page 57)

their temperature maintained at that of the ice by the electric refrigerating plant, in the engine room. After the fish have been packed in the crushed ice, the temperature furnished by the refrigerating machine is lowered to make up for the heat given off by the meat. As soon as the tuna are "stowed," the men return to the fishing, the boat having followed the school slowly all the time. It is useless to fish "against" a school of tuna, that is, in an opposite direction to that in which it is moving, or to attempt to "cross" or cut through a school. These large fish feed in the direction of their migration, and in no other. If the squids are drawn against the school or across it, the tuna start milling in circles, and presently drive out to sea at such a speed that no boat can keep up with them.

OTHER things come out of the sea besides tuna and whale sharks. One night, when the *Buena Ventura* was riding a smooth sea, about 500 miles south of Cape San Lucas and some 500 out on the Pacific, nine or ten of us were lying around under the brilliant deck light, listening to a radio program, when a large flying fish landed in our midst, to be followed immediately by another and another. They appeared uninjured and we dropped them in one of the bait tanks. More flying fish, apparently attracted by the light, came aboard, until we had caught 112 of them. Most of them remained alive in the tanks and we reached San Diego with ninety-seven of them in good condition.

If the tuna schools are still running strong after the fish boxes have been filled, it is customary to empty the bait tanks by the simple trick of removing the screens from the outlets and stopping the intake pumps. Then the bait tanks are filled with fish, packed in the excess ice from below decks, thus adding fifty to one hundred tons to the catch. Since there is no refrigeration connection for the bait tanks, they can be used only when the run back to market is short enough for the ice to maintain a low temperature without mechanical aid.

THERE are many dangers to this long-range fishing. The best of the tuna schools, and the largest fish, are found in the summer storm region from Cape San Lucas southward. There gales "make up" overnight, or a cloudless night may become a raging dawn. There are uncharted shoals, well out at sea, and mud banks, around which the tuna gather in large schools, possibly to spawn, though no one now knows exactly where or when these valuable fish lay their eggs. Derelicts wash into these unfrequented waters far off the steamer lanes.

As we were running northward one night with a full cargo and the *Buena Ventura* low in the water, doing not more than nine knots against a southward-bound current, a black mass, half as high as the wheelhouse, rose suddenly out of the moonless sea close to starboard. One of the men was steering, and I was standing beside him. I first thought it was a mud bank, newly risen from the Pacific. We were about 200 miles off shore and about halfway between San Jose del Cabo and San Diego. I threw the deck floodlight switch and saw in the glare of the light the body of a whale, apparently asleep on the surface.

It seemed to me the largest whale I had ever seen I realized that we were in a very serious position. If we so much as grazed the monster —and he was not more than twenty-five feet away—he would wake and roll or sound. If he did either we would founder. If he turned, and we ran into him, our bows would be crushed in and we would sink like a stone. I shoved the wheel over as gently as possible, so that we would move away at (Continued on page 149)

Three Men to Hook One Fish

(Continued from page 148)

such an angle that the stern would not touch the whale, nor the wash of the propeller waken him. In less than two minutes we were clear and standing inshore.

But the night was not over. I had gone below and slipped off my boots and oilskins when one of the men told me we were being followed.

I went on deck, into the false dawn which was just breaking. There, on the port beam and somewhat aft, was a whale, a humpback, fully as large as the one with which we had so nearly collided in the night. Further back, on the starboard beam, was another of equal size. They came in closer until they were not more than 100 yards off. I blew the air whistle and they dashed away, still on the surface, meeting about a quarter of a mile astern and then coming toward the *Buena Ventura* again. This time, both passed to port, ran ahead at a twelve- to fifteen-knot speed, rounded across our bows about a half a mile in front, and played along the starboard beam and across the stern

IF there is anything I do not care for, it is a game of tag with a pair of seventy-five or eighty-ton whales; so I put in for shore, urging the engineer to get all he could out of the Diesel. But the whales followed us. This continued all day, until the coast line of Lower California came in sight. They were still with us when night came down, but in about an hour left and put out to sea. Had they taken it into their huge heads to stand while they were near the ship, all of us would have been swimming, with the nearest land about 400 fathoms straight down.

You Don't Have to Be a Pilot

(Continued from page 87)

stress and structural analyst rolled into one, in addition to being an imaginative as well as a practical builder. It is seldom that an airplane factory is blessed with one or more such men.

A definite salary is hard to name for an aeronautical engineer, since individual ability varies so much. A good one makes a very comfortable living. There is a popular impression that only college men are fitted for engineering. I have seen some good engineers who never saw the interior of a university.

Of course not every mechanic will become an engineer. Even those that do must be willing to be patient. A young man starting without experience, in the factory, and following the route I have suggested would be fortunate if he managed to qualify as an engineer within ten years. He should count on spending at least two years in the drafting room. I can understand a temptation to skip the work in the shop entirely and try to break in as a draftsman at once — but I wouldn't advise anyone who wants to become a good engineer to do it.

JUST a few samples of things that have actually come from departments supposed to contain competent engineers show why. A plan prepared by one of the engineers calls for a joint in which nickel steel is to be welded to cold-rolled steel. Any shop man knows that these two steels melt at temperatures about 150 degrees apart. By the time you melt one, you are burning the other; such a joint cannot possibly be used. Another design calls for nuts and bolts where no mechanic could ever reach them with a wrench unless he took a whole plane apart. A third conveys the astonishing information that cold-rolled steel is to be heat-treated. It is never heat-treated; this is impossible. (Continued on page 150)

You Don't Have to Be a Pilot

(*Continued from page 149*)

A man who has worked in the factory avoids these blunders. In addition, he knows when, for a given part, it is best and cheapest to use a casting, or a stamping, or a forging.

If an ambitious young man has other plans for the future than in the engineering field, he may elect to remain in the factory and, perhaps, rise to become a factory superintendent. Outside the factory, plenty of other careers are waiting for him, for which his practical factory work has been a splendid preparation.

THE service manager of an air transport line gets from $6,500 to $12,000 a year for taking care of its planes. Another position worth aiming at is that of chief field mechanic at a flying field. Our own field chief, a man named Conway, realized that ambition in only two years from his start as a mecanic's helper.

Designing or building airports is another profitable business. Airplane makers need salesmen, advertising men, publicity men—more opportunities for a non pilot in aviation, particularly if he has learned about planes by building them. Real ability commands executive positions with airlines.

A young man may find that his favorite hobby will earn him a good salary in aviation. If he is interested in radio, there is the chance of employment with the men who are developing plane-to-ground wireless. You read about their experiments every day. He might go up with a radio experimental plane, or work in a ground station that transmits weather reports to flying planes—already an accomplished fact.

An amateur picture-taker may find his hobby profitable in aerial photography. He might be asked to count the trees in a forest for a paper man. Perhaps he will use his camera to hunt schools of salmon. Sometimes an aerial photographer goes out to look for a gold mine, or a herd of reindeer. Mapping, of course, is an important part of the work.

It is not necessary to be an expert photographer. Some of the best aerial photographs were made by novices. An oblique camera, the type used for most air photographs other than map pictures, need not be focused. All that is needed is to snap the shutter at the right moment. The most important qualification for an aerial photographer is one that most persons would never guess. He must be able to find his way. When he is doing aerial mapping, for example, he will have to recognize a certain clump of trees where he last stopped taking pictures. He cannot waste flying time at sixty dollars an hour.

A tyro would start as a photographer's assistant, at a low salary. He would change plates in the air, and carry the camera for the photographer. Eventually he would be taking pictures himself.

NEITHER bad eyes, nor high blood pressure, nor any other minor physical defect is any handicap to a man who takes up one of these non piloting pursuits. The Government expresses this attitude in its Air Commerce Regulations for 1928. Section sixty-four of the chapter dealing with the licensing of mechanics says, "An applicant for a mechanic's license is not required to take a physical examination." That is typical of non-piloting occupations in general.

Probably the activities that I have listed account for what happened to many of the 58,500 persons who failed to get pilot's licenses in the last three years.

Next month: "How I Pilot My Plane," by Randy Enslow, Lindbergh's former barnstorming partner. A veteran pilot tells exactly how he meets the problems which every flyer must solve.

Advice for POPULAR SCIENCE MONTHLY readers regarding safe and profitable investments. See Page 4.

Tying Europe to America by Telephone Wires

(Continued from page 82)

spaces of the untamed West. But that is where Frank B. Jewett hails from, where he was born and reared and got his first impulse toward engineering and science.

His father, Stanley P. Jewett, a civil engineer, went to California in the '70's for his health, and Frank Jewett was born, in 1879, in the town now known as Pasadena, California.

"When my father settled there it was known as 'Indiana Colony' and had not more than a dozen houses," Dr. Jewett told me. "When I was born there may have been twenty houses. Not far away was the Mexican city of Los Angeles, with perhaps 10,000 population, ninety percent Mexican and Spanish."

That was the old Southwest in its pioneer days. There was a railroad, the Southern Pacific, running from San Francisco to Los Angeles. Men were talking about throwing rails across the desert, over the Great Divide and so across Arizona and New Mexico to Texas and the East. The elder Jewett, his health regained, joined with others to lay the first steel of what is now the Santa Fe system, from Pasadena to Barstow. Tobacco-chewing, gun-toting he-men swarmed into southern California to boss the Mexican peons who did the manual labor, and in their company young Jewett got his first lessons in practical engineering and the management of men.

PASADENA grew into a city with ambitions. One of its most ambitious enterprises, founded on the benefaction of one of its citizens, was the Throop Polytechnic Institute, now the California Institute of Technology, and there Frank Jewett entered in one of the earliest classes, graduating at nineteen with the determination to become a mechanical engineer, but with an intense thirst for more scientific knowledge than his school could provide.

To get that he had to go East, and he took the leap from coast to coast in two strides. First, the University of Chicago, working there as research assistant in physics under the great Michelson, and getting his Ph.D. at twenty-three. Then to Boston and the teaching job from which he was drafted by the telephone people, his railroad ambitions gone glimmering.

"I suppose they picked me because I was an unusual combination for those days, a physicist who had had practical contacts with industry and did not look down on business as something beneath the notice of science," he said, by way of explanation of how he came to be chosen.

HIS job grew as the telephone business grew. Some research work was being done in Boston, some in New York, and much in Chicago, where the Western Electric Company, manufacturing apparatus for the telephone company, had its headquarters. Dr. Jewett worked in all of these laboratories. Gradually they were consolidated, and when that had been done, and the largest group of industrial scientists ever assembled in one organization found itself under one roof in the great Bell Telephone Laboratories in West Street, New York, Dr. Jewett found himself at the head of the whole works. And that is the job he likes to talk about.

"It's a job of organizing scientists and engineers into a team capable of tackling any problem of the industry set before them," he said. "And not the least important part of the job is that of interpreting the possibilities and limitations of research to the executives of the industry."

That, I thought, accounted for the polished manner, the successful-business-man atmosphere which surrounds him. A man may be a great scientist and

(Continued on page 152)

Tying Europe to America by Telephone Wires

(Continued from page 151)

never be able to "sell" science to business men, unless he can look, act, dress, talk, and, on occasion, think like a business man. It is an interesting speculation as to what might have happened to Edison if he had been more particular about having his trousers pressed.

Dr. Jewett disclaims any personal credit for the achievements of his staff, other than that he has to make the decisions as to which problems to undertake and who to put at them. "I have two or three patents of minor importance to my credit," he said, "but my job is one of management, which in this case calls for an understanding of the needs of the industry as well as of the possibilities of scientific investigation."

I asked him for specific examples of how problems have been tackled and solved under his direction.

"A GOOD example is the research which resulted in substituting electrolytic iron dust for bundles of soft iron wire as a core for telephone loading coil," he said. "For years we had to maintain an enormous wire-drawing plant, using diamond dies to draw the iron wire. The cores were expensive and difficult to make. A young man named Buckner Speed came to me with the suggestion that cores could be made of electrolytic iron dust, highly compressed, if some way were found to insulate each dust particle, so as to get the same effect as a bundle of wires. I authorized work to be done on this problem, with the result that an iron dust type of core, electrically much better than the iron wire core, was evolved in the laboratory.

"That was one of the first improvements on the loading coils invented by Professor Michael Pupin and developed commercially in our laboratory. And the Pupin coil, in turn, was the beginning of long-distance telephony. By "loading" the telephone circuit with inductance coils spaced at proper distances apart, the distortion and losses of the impulses in the wire are corrected. Professor Pupin worked out an engineering method for doing this, and patented it. We bought his patent and turned over to Dr. G. A. Campbell and Dr. E. H. Colpitts the task of finding out how to make coils of high inductance, low energy loss, and low cost, and how to install and maintain them on telephone lines in accordance with Pupin's rule. They did a really brilliant piece of research, involving the need of devising new types of measuring instruments. That work has been going on for many years, with increasing results.

"WE NO longer use loading coils on open wire lines, the vacuum tube telephone repeater invented by De Forest taking their place; but on cables we use more and more of them, and as fast as it is economically desirable, we are burying our telephone wires, running them in cables between the large centers of population. By the end of 1929 more than 5,000,000 loading coils will be in use on the cable circuits of the Bell system alone."

One thing leads to another in scientific research. The idea that some magnetic substance even better than electrolytic iron might be discovered set a problem on which Dr. O. E. Buckley and Dr. G. W. Elmen worked for years. They discovered an entirely new alloy of nickel and iron, which had several times the magnetic permeability of soft iron, and so was named permalloy. Another revolution in long-distance wire communications began with permalloy. The first important application of it was to a transatlantic telegraph cable. Loading coils can't be placed along the bed of the ocean, but by wrapping the core of the cable with a thin spiral strip of permalloy the same effect was pro- *(Continued on page 153)*

Tying Europe to America by Telephone Wires

(*Continued from page 152*)

duced and the speed of telegraph cables was multiplied by ten or so.

"Permalloy, however, wasn't good enough for telephone purposes," Dr. Jewett told me. "The high-frequency telephone current was still subject to too great a loss to make conversation over the permalloy-loaded cable possible. So Drs. Buckley and Elmen set at work until they discovered an even better magnetic material, adding cobalt to the nickel and iron, and producing perminvar.

"Now we are approaching the climax of years of research, preparing to lay the first submarine telephone cable connecting two continents. Besides the work on magnetic materials contributing to this result, we have been carrying on another line of research in insulating materials. Gutta percha has been the sole material used for insulating telegraph cables. Its electrical properties, however, are not good enough for telephone purposes. The complex waves of speech and the high frequencies involved require that the material used for insulating the conductor must have the minimum of transmission loss.

"THE new material developed in our laboratory is known as 'Paraguttа.' As its name implies, it is a compound of rubber and gutta percha. Now the transatlantic telephone cable is out of the laboratory and in the stage of manufacturing development. This reduction to shop practice on a commercial scale is being done in one of the three large submarine cable factories of the world, the Norddeutsche Seekabelwerke at Nordenham, Germany. Here there are large metallurgical problems involved in perfecting the manufacturing technique for the production of perminvar, and in developing methods which will permit of its being rapidly and effectively applied to the conductor. There are also chemical problems concerned with the manufacture of Paraguttа of absolutely uniform character and purity, and with the technique for its application to the loaded conductor.

"These problems have been met in the laboratory, and we believe all can be solved in the factory. When they have been, continuous, uninterrupted telephone communication between every part of North America and all of Western Europe will be possible, using metallic circuits all the way. And that will be the longest step in advance that the telephone has made."

"But why the telephone cable?" I asked. "Isn't the radio telephone working all right?"

"UP TO a certain point, yes," replied Dr. Jewett, "but it isn't good enough. Radio is not sufficiently reliable to use as the sole means of telephone communication between the two continents. Although considerably cheaper than a cable, its lack of secrecy, its susceptibility to static noises, and, particularly with the shorter wave lengths, its tendency to fade out completely for long or short periods, deprive it of the reliability essential in the telephone business. Last winter there were periods when radio communication by means of short waves was virtually nonexistent all over the world. Delays of several hours are not infrequent; and while much progress probably will be made in perfecting radio transmission, some of the causes of trouble appear to be beyond human control.

"The logic of events calls for one or more telephone cables, which will be the 'Old Reliables' of transoceanic conversation, the backbone for a service which can be depended upon at all times. Service over the cable will never be complicated by atmospheric conditions or the absence of sufficient channels.

"The cable will be too expensive to carry the whole load. Radio, (*Continued on page 154*)

Tying Europe to America by Telephone Wires

(Continued from page 153)

when it is good, is very good indeed, and it is very much cheaper than the overhead cost of cable operation. I anticipate that within a few years there will be one or more cables as the backbone of the ultimate service, two or three long-wave radio channels, and three, four, or five short-wave channels in use for transatlantic telephony.

"With some such set-up as that, there is hope of furnishing a thoroughly reliable telephone service between Europe and America."

"DO YOU believe that wires eventually will displace radio for all point-to-point communications?" I asked Dr. Jewett.

"Theoretically, yes," he replied. "Eventually wire service will be extended to every part of the world where business conditions make it economically advantageous to do so.

"Unless someone invents a new method of radio transmission, radio will always be in the position of a pioneer, to be displaced by wires as soon as the economic situation warrants. One reason is that there are not enough noninterfering radio channels to go around. There are legitimate uses for radio which the wires never can supplant, and which are crowding, even now, the available channels. The development of aviation and of means of communication between the ground and aircraft in flight is one of these uses which are multiplying the normal field of radio immensely. Ship to shore communication is increasing, so is broadcasting; and these, with military and naval uses, may well use up all the available wave lengths."

"After the telephone submarine cable, then what?" I asked. A director of industrial research must be a prophet, among other things.

"NOBODY knows," he replied. "Improvement of instruments and switching methods, naturally. The telephone system is like an inverted pyramid, resting on an apex which is the telephone instrument itself. It took many years of research to bring the new one-hand instrument, which combines the transmitter and receiver in one, to such perfection that we could substitute it for the standard desk set.

"PHYSIOLOGISTS in our laboratory had to study the anatomy of the functioning of the human ear as never before. One by-product was the discovery of new knowledge of how sounds are captured by the ear and transmitted to the consciousness. Other scientists made new studies of the voice-producing mechanism of the larynx, until we have been able to make an artificial larynx with which a human being or a machine can actually talk. Such artificial larynxes have been used by surgeons to replace natural organs which had to be removed as the result of disease. Further improvement of telephone instruments until they are as perfect as it is possible to make them is one of the three goals at which we are aiming; the other two are perfection of the transmission lines and the perfection of mechanical switching.

"The time is close at hand when all telephone switching in all of the larger metropolitan areas, at least, will be done mechanically. The laboratory has to develop means of doing this more certainly and economically. Without mechanical switching the cost of telephoning would increase with the number of telephones; with mechanical switching it can be kept within reasonable bounds. Always there is the economic need to be served by the laboratory."

There is the picture, then, of Frank B. Jewett, the research director in industry. A combination, it would seem, of scientist, engineer, business executive, economist, prophet, and diplomat, able to make the business man understand what science can do for him; able to reconcile the scientist to devoting his science to the practical needs of the world.

Here Are Correct Answers to Questions on Page 54

1. "Slow movies" really are high speed movies projected at normal speed. Standard practice has been to take ordinary movies at the rate of about sixteen pictures or "frames" a second. High speed movies are taken at the rate of 128 a second, which is eight times faster than standard. When projected at the standard rate of sixteen a second, action taking place in one eighth of a second is spread out over a full second, so that every motion appears to take eight times longer than it should.

2. The sound is recorded on a narrow strip along the edge of the picture space. It is picked up by the studio microphone, which translates it into equivalent electrical impulses. These impulses, after amplification, are again translated, this time by a neon light, into equivalent light impulses, which are recorded on the film. In another system the electrical impulses vibrate a mirror so that more or less light is reflected from a fixed beam onto the film.

3. Motion picture film is made of celluloid, which is highly inflammable. Since all the light that illuminates the screen must pass through the small area of the film in a concentrated and extremely hot beam, there is always a possibility of setting fire to the film. If the film sticks, for instance, and the automatic shutter fails to drop in front of the film and protect it from the light beam, it will take fire almost immediately.

4. The moonlight scenes you see on the screen are taken either at sunrise or at sunset. The positive film is printed darker than normal and then stained with a blue dye. No satisfactory results can be obtained with a motion picture by moonlight, even with extra fast lenses. Still moonlight pictures can be taken with an ordinary camera, however, if it has a fast lens and relatively long time exposures are made.

5. The image on a motion picture film, as with ordinary camera film, is made up of tiny particles of metallic silver. If you enlarge too much, the grain of the film becomes visible. The motion picture on the screen appears sharp because the grain that appears in any individual picture is immediately replaced by another frame in which the grain pattern is totally different. Thus the average detail sharpness is much better than in any individual frame or picture.

6. Unless you are sitting in the front row the sound is bound to reach your ears a fraction of a second after the visible impression with which it is synchronized. This is because sound travels much slower than light. Sound travels at a speed of 1,100 feet per second; light at about 186,000 miles a second.

7. The ludicrously fast action obtained in the slapstick comedies is obtained by operating the camera at considerably below normal speed—just the reverse of "slow movies." If the crank on the camera is turned at half or quarter normal speed, the film, when projected at normal speed, will show action two to four times faster than normal. A knowledge of just how fast to turn the crank to produce the desired effect is of immense value to the man engaged in "shooting" comedy features.

9. Home movie film is developed and then reversed to positive to save the cost of the extra film required when a separate positive is printed, and to save the cost of handling the film during the printing process.

10. The ideal location from which to view motion pictures is from a seat in line with the center of the screen and sufficiently far back so that you do not have to look up.

A New Invention to Harness the Sun

(Continued from page 23)

use of high temperature does not necessarily guarantee efficiency. Losses by conduction, radiation, and excessive friction must be eliminated.

As to steam engine losses, a recent test of a 4,000-kilowatt turbine plant, using superheated steam with an overall efficiency of nineteen percent, showed a boiler efficiency of eighty-two percent, a thermal engine efficiency of twenty-five point eight percent, and a mechanical efficiency of ninety percent. Here the chief cause of efficiency loss is the fact that the turbine uses only a quarter of the available heat, most of it going into the exhaust. This is because the temperature of the steam before it is used is not high enough.

IN A typical case of an internal combustion gasoline engine of twenty percent efficiency, there is a loss of forty-one percent to the cooling water, thirty-four percent loss of heat in the exhaust and by radiation, and five percent loss through friction. In the gasoline engine, where temperatures run much higher than in the steam engine, not so much is lost in the exhaust. Nevertheless, the high temperature involves a serious loss of heat to the cylinder walls. Nearly half the money spent for gasoline is lost in this way.

In the proposed solar engine the steam engine's loss of efficiency is avoided by using at the focus a temperature as high as, or even higher than, that of exploding gases in the gasoline engine. There is no loss of heat to the surrounding water, because any heat conducted or radiated from the focus point to the incoming water simply pre-heats it.

The light weight of the proposed solar engine offers interesting possibilities for its use in aerial navigation. The steam generator itself is extremely compact and can be made of light materials. Sunlight, of course, is a weightless fuel. The only part of the whole outfit, therefore, about which there would be a question of weight is the reflecting mirror. But since its only operating part is the reflecting surface, quite possibly it could be made of a thin layer of light fabric coated with a highly polished metal foil. Perhaps the upper surface of a dirigible might be made into a series of shallow, foil-covered concave mirrors focused on a row of solar motors placed in an upper streamline l structure. Such a combination would produce a dirigible of unlimited cruising radius.

Recently another possible use for solar power has been mentioned in connection with my experiments in the science of interplanetary navigation which the French have named "astronautics."

In 1919 I suggested the possibility of producing a rocket so powerful that it would leave the earth's surface never to return. Since then there has been considerable speculation regarding the use of such a rocket in the navigation of interplanetary space. It is in this connection that I have been interested in developing a very light and efficient solar engine such as has now been designed.

The practical and obvious first use for the new solar motor, however, is to supply abundant and cheap power for mankind. And while an old maxim states that you cannot have your cake and eat it, too, you can use sunlight to develop useful power without fear of reducing the heating effect of the sunlight on the earth. No matter how many thousands or millions of solar motors eventually come into use, the temperature of the earth will not be influenced one iota—every single heat unit used in a solar motor will finally be absorbed in the earth.

An article in next month's issue will tell how the latest developments in science of welding are working a revolution in steel construction.

Who "Planted" the Glozel Fakes?

(*Continued from page 54*)

at Paris; Professor Espérandieu, of the Institute de France, and Professor Mendes-Correa, of the University of Porto, Portugal.

Dr. Morlet laid the exhibits before these authorities, and some made independent excavations. All of them were astounded by what they found. All of them, with the sole exception of Dr. Julian, declared that here was the most wonderful archeological "find" ever stumbled upon. Yes, the urns and stone implements and flint weapons were Paleolithic. Yes, the bone instrument and ornaments were Neolithic, or belonging to the Bone Age, the period that followed the Stone Age. In other words, these things were from 10,000 to 13,000 years old. They were priceless.

BUT, asked Dr. Morlet, what of the markings and hieroglyphics? There were more than a hundred different signs and characters. Most of these resembled the letters of the Phoenician alphabet, but others looked like old Greek, Etruscan, and Iberian writing. How did they get on objects made by cave men? And how was the glazing of the bricks in the trench to be explained? Had not the art of making glass been invented many centuries after the Bone Age?

The savants carefully reëxamined the collection. At last they agreed—all but Dr. Julian—that the excavations proved the existence of man in a high state of civilization in fabulously prehistoric times. The whole conception of history had been wrong. Prehistoric Europe, until then considered the hunting ground of extremely primitive people in its early days, was the real cradle of civilization.

At that point, the famous controversy entered its first phase. Dr. Jullian dissented violently. The "find," he said, was merely the hoard of a sorcerer from the third or fourth century of the Christian era, who had gathered all the prehistoric junk to be found in that neighborhood at the time and had used it to impress his simple shepherd-clients in his practice of witchcraft and necromancy. The apparent glazing of the trough, he believed, was a chemical accident, due to the presence of potassium in the soil.

But he was unable to convince his colleagues. They began writing articles in archeological and anthropological publications, announcing their marvelous discovery and setting forth their startling theories. Dr. Jullian, too, broke into print. He published his own "translations" of the inscriptions on the tablets, interpreting them as the incantations of a Gallo-Roman magician.

NOW the row was on in earnest. With the exception of Dr. Reinach, Professor Loth, Professor Espérandieu and Professor Mendes-Correa, each of whom had his following, virtually all of the leading European scientists bitterly opposed the Glozelians. They were led by Réné Dussaud, curator of the prehistoric section of the Louvre, the French national museum in Paris, who prides himself on his knowledge of ancient inscriptions, especially the Phoenician, and who, from the first, declared the Glozel "relics" to be crude forgeries. Dr. Jullian also had his enthusiastic adherents. And so the European world of science was split into three bitterly hostile camps.

Meanwhile, fresh discoveries were made on the Glozel farm. Emile Fradin and Dr. Morlet opened two more "tombs" made of loosely joined stones. In some cases, these stones were embellished with animal etchings, including pictures of reindeer, resembling those found in caves in Southern France. Again, the troughs were filled to overflowing with an assortment of curious objects. There were vases of many

(*Continued on page 160*)

Who "Planted" the Glozel Fakes?

(Continued from page 158)

shapes, axes, arrowheads, bone harpoons, and fragments of glass goblets and other vessels. In all, young Emile's "museum" now harbored between 3,000 and 4,000 exhibits.

The additional findings fanned the conflict to even greater heat. Matters went from bad to worse until, in September, 1927, the congress of the International Institute of Anthropology at Amsterdam appointed its committee to investigate Glozel and settle the dispute. It consisted of Professor Bosch-Gimpera, of Barcelona, Spain; Miss Garrod, of London; Dr. Ferrer, of Strassbourg, France; Dr. Hamal-Nandrin, of Liège, Belgium; Professor Pittard, of Geneva, Switzerland; and Dr. Peyrony, curator of the Prehistoric Museum at Eyzies, France, all of them archeologists of European reputation. The French government ordered Dr. Peyrony to make an official report.

THE commission began its investigations at Glozel in the beginning of November, and its report that the whole find was a swindle was made public two months later. The intensity of the controversy which followed may be judged from an experience Professor Loth had as recently as the spring of 1928, when he attempted to give a series of lectures on his personal observations at Glozel in the Collège de France. The anti-Glozelians in the hall began pounding their desks as soon as he started to speak. The Glozelians took the antis, one by one, and threw them out of the building. They came back in a body, armed with stench-bombs and, when they found the doors barred against them, bombarded the windows with bricks. The riot was finally quelled by the police. It was after this brawl that the word "Glozel" was made taboo by all French scientific societies.

In the meantime, several suits for defamation of character and libel had been started in the French courts and the recent devastating findings of M. Bayle were the outcome of these legal proceedings.

Now that the fraudulent nature of the Glozel excavations seems established beyond a doubt, the question arises: Who "planted" them and why? Was it the work of a jokesmith who wished to satirize the tendency of some scientists to let enthusiasm run away with judgment and substitute imagination for concrete evidence? Or was the fraud conceived by the disordered mind of a maniac who once had been a man of sound learning? Emile Fradin charges admission to view his collection. Was the fake inspired by a desire for gain?

TIME may tell. The authors of most of the scientific frauds of the past were discovered sooner or later and their motives exposed.

Scientific hoaxes, tricks, and delusions are almost as old as history. They range from the mystifications of the sorcerers of antiquity and the claims of the alchemists of the Middle Ages, some of whom professed being able to transmute base metals into gold, to the ministrations of the quacks of more recent periods and the pretentions of scientific charlatans of the present day. And they will continue to meet at least with a measure of temporary success so long as the late Mr. Barnum's famous dictum holds good.

Jumps from Speeding Plane

JUMPING with a parachute from an airplane speeding along at 120 miles an hour is a new kind of world's record, claimed by Karl Schreiber, German airman. He performed the feat 1,600 feet above Berlin. Now he has filed claim for official recognition with the German Aviation Association.

Making the Floor Suit the Room

(Continued from page 77)

I expect you'll want wood floors there?" Mrs. Kersey answered. "Yes, and I've found out how to get an effect that I want. There's a shade of green that I love, and I've always wanted a bedroom finished in it. I don't like a painted floor in a bedroom, but today I saw floors in all colors with the grain showing through the finish."

"Yes, that can be done. The floor is stained after it is laid, and then finished with varnish or wax. What kind of wood did you see?"

"Maple; but the man said that it could be done with oak, too. It gave me ideas for all of the bedrooms, and I think we'll have colored floors in all of them."

"Well, that's the modern idea. How about the bathrooms; color there, too?"

"Oh, yes indeed. I haven't changed my plan for a green tiled bathroom; that'll be ours, and the other will be in tan and rose. And what I'm going to do with tiles in the conservatory!"

"AND there's another place where you might use them—the passage between the dining room and the living room," said the architect. "One side looks out on the terrace, you know; so it can be informal. But there I suggest something else—brick, common brick. Have it rubbed down to a smooth surface with sand and water and another brick used just like a sandpaper block. Then wax it. You'll get a marvellous tone, and it'll be out of the ordinary. You might use brick for the service porch, too. Did you see anything that you liked for the terrace?"

"Yes, irregular slabs of slate. But the cement between was white, and I didn't like it; it was too glary. Can't it be colored?"

"Yes, any color you want. It isn't painted; the color is mixed in, and goes all through."

Mrs. Kersey asked what was done to wood to give the effect of quartering.

"It's in the sawing," answered the architect. "If you look at the end of a log, you'll see that there are two kinds of markings; the growth rings and a grain that runs out from the center like the spokes of a wheel. In straight sawing, a log is sliced lengthwise, so that the cut is along the rings but across the other grain. When it is quartered, the saw strikes the radial grain edge on, so that instead of the board showing a grain that is more or less parallel, there are all sorts of wide and narrow markings. It is far more beautiful. Quarter-sawed flooring costs a little more than plain-sawed, but there's no difference in the cost of laying it, and for that small increase in price you can have a floor that is really fine instead of one that is ordinary. It makes a better floor, too, for the broad places in the grain are harder than the wood between."

THE only floors for the Kersey house that had not been discussed were for the cellar and the garage, for it was a matter of course that these should be concrete. In the cellar, however, the architect planned a detail that he knew by experience would go far to reduce dampness caused by the condensation of moisture as warm and damp air was chilled by the cool concrete. While the floor was being poured he planned to mold a shallow gutter in it by setting two by fours on edge in the soft concrete at the foot of the walls all around the cellar. This gutter would slope toward one corner and be connected to the outside drain. By this simple arrangement the drip of water from the walls would be passed out, and with good ventilation the ill effects of a damp cellar would be avoided.

Next Month Mr. Whitman will tell how money can be saved in house building by spending it.

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Streamlining for Speed

(Continued from page 81)

air or water passes a long tapered surface.

The importance of an understanding of these principles in engineering is apparent when it is realized that a train moving at only fifty miles an hour into a head wind of the same velocity bucks a wind resistance of nearly a ton's force. A 200-mile-an-hour auto, such as those that have raced along the Daytona Beach sands at Florida, fights a four-ton force of air holding it back. Airplanes, with their even swifter speeds, fight still greater pressures compared with the amount of surface exposed. For wind resistance increases, not directly in proportion to rising speed, but even faster—as the square of the velocity, engineers would say, or more at very high speeds. Is it any wonder that engineers seek an ideal shape for vehicles that will minimize air resistance—in other words, a streamlined form?

A GLANCE at the design of the fastest vehicles in the world shows what an important part streamlining plays. It is most striking in the super-speed airplanes which at this writing were being tuned for the Schneider Cup Race in Great Britain, and the Italian plane that made a world's record of 318 miles an hour last year, with a top speed of 350 miles an hour for one measured lap of the course at Venice. Such a plane is streamlined to the last degree. Screws on its body are countersunk flush with the surface, and even nuts and bolts are of streamlined design. So are the tiny wires that brace the struts and pontoons, when seen in profile.

Curiously designed to cut down every possible ounce of wind resistance is the 231-mile-an-hour *Golden Arrow* automobile that Major H. O. D. Segrave, British auto racer, piloted to a world speed mark on the sands at Daytona Beach, Fla., in March of this year. Its streamlined "fuselage" body type possesses such other unusual features, for an automobile, as a tail fin to keep it from swerving at its high speed, and horizontal fins to hold it on the ground.

LESS obvious is the streamlining in Gar Wood's famous speedboat, the *Miss America VII*, which that veteran sportsman drove to a world's record of ninety-four miles an hour on Indian Creek, Florida, last March, but it is there, none the less. But where airplane and automobile have only air resistance to contend with, the *Miss America* navigates in two mediums—air and water—and this complicates the problem of streamlining. Actually the result is a compromise between design for least resistance and for stability—resulting in a nonstreamlined "step" on the bottom which lifts the boat, at high speed, nearly out of the water. Another compromise in her design is typical of fast water craft that travel on the surface, as distinguished from "displacement" boats that go through the water instead of skating along on top. Above the water line normal streamlining can be seen.

At this writing the largest streamlined object in the world was the 776-foot *Graf Zeppelin*, Germany's cigar-shaped dirigible. Its symmetrical outline, however influenced by considerations of strength and rigidity, is not as perfect a streamlined form as that of smaller "blimps" with blunt nose and tapered stern. Meanwhile a giant structure was rising at Akron, O., to wrest away the honor of the largest streamlined thing—a mammoth nine-acre hangar to house the two new 6,500,000 cubic-foot dirigibles to be built for the Navy, and, eventually, two others like them for commercial transpacific service. Even a gentle wind blowing against this 1,200-foot-long building would endanger the opening of its massive doors were it not for the curious tunnel-shaped design of the structure to minimize wind resistance, and the

(Continued on page 163)

Streamlining for Speed

(Continued from page 162)

rounding of the portals to resemble quarter-slices of orange peel.

And the smallest streamlined thing? That is a close contest, with both man and nature offering candidates. On man's side, his most diminutive effort at streamlining is probably the thin airplane wire of streamlined cross-section used in bracing fast planes. One of Nature's best examples is one of the smallest fish known, a creature only half an inch long when full-grown, that inhabits volcanic lakes in the Philippine Islands. Another is a falling raindrop, a classical example of streamlined form, which automatically takes on the elongated shape of least resistance to the air.

A novel application of streamlining, the shape of the funnels of the speedy liner *Bremen*, is based on the falling raindrop shape. In profile each of the funnels has a blunt front and tapered rear, the object being, of course, to minimize wind resistance. The same liner furnishes in the shape of its bow, hull, and rudder other unusual and interesting examples of extreme streamlining design (P. S. M., Oct. '29, p. 22).

THE layman would hardly think of looking elsewhere for examples of streamlining than in fast-moving vehicles yet even in the parts of industrial machinery it may play an important part, as a single example will show. Through a mighty penstock several times taller than a man in diameter, water surges into one of the 70,000-horsepower turbines at Niagara Falls, the largest generating units of their kind in the world. After its 214-foot fall this crushing weight of water hurls itself against a valve of peculiar shape that blocks the inlet to the turbine. The valve, hydraulically operated, is shaped very much like a submarine—a great hollow cylinder with tapered ends. It is streamlined. Were it not, the water pressure would instantly tear it loose and send it crashing against the inlet orifice. But with its shape of minimum resistance, it stays in place and moves smoothly backward or forward to control the flow of water into the giant turbine.

MAN has applied well the principles first used by the original streamlined thing—the fish. Perhaps there are still lessons to be learned. Thanks to its streamlined shape, a trout can glide along at seven miles an hour, and a pike at ten, according to expert estimates. Modern submarines can do little better. And although no definite figures are available, it is likely that such salt-water fish as mackerel and amber-jacks, the latter a speedy tropical form, can reach double the speed of their fresh-water cousins.

Fast-swimming fish that inhabit the middle depths of the open sea show streamlining to the most marked degree, according to C. M. Breder, Jr., research associate of the New York Aquarium, and one of the foremost authorities on the locomotion of fish. Some that appear at a glance to be far from streamlined actually possess this essential characteristic. One interesting example is a species of ray fish. It has wide horizontal fins faintly resembling a bat's wings. Examination shows that they, as well as the fish's body, are streamlined in cross-section. What is more, Breder declares, four-footed forms of animal life that have reverted to marine existence at some time in the dim geologic past—such as whales, dolphins, and the now extinct ichthyosaurus—have at once taken on a streamline form in keeping with their new habitat. For slow-moving land animals—and this includes human beings—streamlining would be worse than useless. But for machines which man has devised it means efficiency, and for many living things it means life itself.

Poison Gas for War on Rats

(Continued from page 46)

forty-five freight cars or make a line of dead rats about 600 miles long, were exterminated. Thousands of men, women, and children participated. The chief weapon used was barium carbonate, a poison fatal to rats but harmless to human beings.

But there is another and brighter side to the picture. Poetic justice has been visited upon the rat. After killing millions of men and devouring or spoiling their stores for centuries, many thousands of rats now sacrifice their lives annually in scientific experiments designed to prolong the life and guard the health of man. White or albino rats, which sprang from the vicious black variety and have been kept as pets for more than 200 years, are used for this purpose.

Since cancer develops in the animals, they make excellent subjects of research in laboratories investigating cancer.

THE Government testing bureaus also use white rats to determine the margin of safety in administering highly poisonous drugs, especially arsenic preparations. This is done by injecting into a rat of a given weight an accurately measured quantity of the poison intended for use in treating human beings. If the rat dies, the drug is dangerous. If it lives, the poison is safe for human use.

In the last six years, much of the research work for the prevention and cure of rickets by ultra-violet light has been carried out on rats because of the ease of producing in them characteristically rickety bones.

The fact that the rat resembles human beings in structure, growth, and bodily processes makes it eminently useful in these investigations. Moreover, its dietary habits also are so like those of man that the animal has become indispensable to the laboratories of food and diet specialists. And because of its unusual intelligence it is further used by psychologists in mental tests of various kinds designed to throw new light upon man's intellectual processes and his reactions to environmental conditions.

AS A result, the breeding of white rats for scientific purposes has become a new American industry. At the Wistar Institute of Anatomy and Biochemistry, at Philadelphia, $60,000 worth of special equipment is maintained for the rearing of the creatures. They are shipped to all parts of the United States and many foreign countries. At Columbia University, New York, alone, more than 9,000 pedigreed specimens are under constant observation, so that new secrets of heredity may be learned and new means for the combating of disease may be evolved.

Rats have proved particularly useful in the study of heredity, because the laws governing rodent life in this respect are fundamentally the same as those affecting the human family. But whereas it would require the better part of a century to observe four human generations, rats tell the same story in about two years.

With the aid of ingenious devices such as problem boxes and mazes, psychologists have established the mental habits and reactions of rats and from them deduced facts that have enriched the science of education.

THUS, the white rat has become a valuable friend of mankind. And perhaps it will be the irony of rodent fate that this creature, indirectly at least, will develop into the Pied Piper that will lure its plague-carrying black and brown kin to their doom. Hundreds of white rats have died in recent laboratory tests to determine the effect of "ratinin," a bacterial culture which does not harm human beings but which spreads an epidemic among the long-tailed pests when placed upon bait.

Vaults to Outwit Safe Crackers

(Continued from page 48)

The bank had moved, and the two-story vault had to be razed. Its outer shell was a four-foot thick wall of concrete for fireproofing, and for protection against mobs and earthquake shock. Then came a six-inch thickness of a material especially developed as a protection against the cutter-burner. It consisted mostly of iron cut in large square slabs, its outside face tool-proof and its inside filled with a core of magnesium oxide—a crystalline material manufactured at Niagara Falls under a fusing temperature of 8,000 degrees F., and proof against tremendous heat. Inside this came a seven-inch buttressing wall containing steel H-columns, heavy metallic ribs, cross-wise round bars, a filling of rich concrete, and a binding of steel plates half an inch thick bolted to the H-beams. The doors of the vault were smooth-faced, conical plug doors impervious to explosive. This was the vault that had to be wrecked.

It was the first time in history that it took weeks longer to raze than to construct a bank vault. A competent wrecking company using the most modern tools found itself all but baffled. The best progress that the wreckers could make through the walls, even with the advantage of being able to attack them from the inside, was half an inch a day. Working at top speed, for they were paid a lump sum rather than on a cost-plus basis, the wreckers took thirteen and a half weeks to demolish the vault. Although a safe breaker might have entered it in less time, it is doubtful that he would have cared to tackle the job.

WITH the design of formidable vaults that cannot be entered within several hours at least, there is a temporary truce between the safe builders and thieves. It would be absurd to assume that the struggle between them is at an end. Temporarily the advantage lies with the protectors of money, but engineers say that advantage may easily be lost by over-confidence or lack of progress on the banker's side—or through some unexpected development in the safe cracker's art.

Finally there is always the threat of the super-criminal. While most crooks are stupid, lacking in imagination and ability, there is no guarantee that this will always be the case. At any time a modern Jimmy Hope may arise among the underworld ranks, to direct a skilled attack upon a large bank. It is against this possibility that vault builders are constantly matching wits in their thrilling war against the unseen.

Neon Lights Give Color Effects in the Home

NEON lights, the multi-hued tubes widely known as adver tising beacons, now have found employment in private homes. They have recently been used to illuminate living rooms, gardens, and swimming pools on the estates of California residents.

A Los Angeles real estate man was the first to illuminate his swimming pool with the novel lights. Several tubes submerged in the water flood the whole pool with a soft diffused light. Since they produce a form of "cold" light, the tubes are not damaged by the water.

Neon tubes concealed in a garden trellis produce artificial moon light for a Pasadena, Calif., public utility executive. Another man has installed red and green tubes behind panels of frosted glass in his living room, where their hues heighten the effect of modernistic decorations.

Small doorway initials formed of neon lights, are found to give a decorative spot of color. Spray of fountains sparkle in blue, green, yellow or reddish tones from artfully placed lamps.

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"Empty Space" a Cloud of Dust

(Continued from page 85)

Then let one human being expel one good breath of air from his lungs. That single lungful of oxygen and nitrogen, expanded to cover the whole United States about a mile deep, would produce an atmosphere about as dense as the cloud of atoms in space.

No wonder that the cloud is too thin to stop light rays. Doctor Struve calculates, also, that it is too thin to interfere with the movements of planets, stars, or nebulas as they fly through space. Extreme thinness explains, too, why the space cloud can be hot and still be unable to warm a hand that touched it. Temperature lacks its ordinary meanings when one deals with only a few atoms of matter in a cubic mile. A single spurt of hot air from a furnace will burn things less severely than will a piece of iron equally hot. There is a larger quantity of heat in the iron than in the air. In the space cloud the quantity of heat available is almost nothing.

A PROBLEM of this space cloud is how it came into being. One theory suggests that it may be a remnant of the original universe; for Professor J. H. Jeans and others hold that the universe was once a vast, uniform cloud of atoms filling all space, and that this primeval gas cloud slowly condensed, to nebulas, stars, solar systems, and planets.

Another theory of the space cloud ascribes it to atoms cast off by the earth, the sun, and other stars, as well as by the gigantic spiral nebulas, inside one of which the earth moves.

Knowledge that these spiral nebulas really are gigantic revolving star clouds many thousands of light-years in diameter has given astronomers a new picture of the universe. Stars are not scattered uniformly through space, they are confined to the spiral nebulas, about 40,000,000,000 stars making up the average nebula. At least 300,000 of these nebulas exist, it is computed, in the known universe. Being in rotation like a gigantic pinwheel, the average nebula is flattened, having about the shape of a very thin watch. From the earth's place inside one of these, the Milky Way represents, astronomers say, the greater thickness of the watch as one looks out toward its edge.

FOR some idea of the whole known universe, imagine about twenty tons of watches, each minus its stem, scattered through a sphere of space about two miles in diameter. That means watches averaging about eighty feet apart in every direction. Each watch represents one spiral nebula. The tiniest crystals of brass or steel inside the watches, even the atoms of these metals, represent the billions of stars of which the nebulas are composed. The whole two-mile-wide, watch-sprinkled sphere is a good model of the universe as astronomers conceive it.

To represent the newly-discovered space cloud of atoms, imagine another ten tons of watches ground up in a gigantic mortar to the finest conceivable powder and scattered between the watches as particles even tinier than atoms. Even in this enormously reduced two-mile model of a real universe perhaps 300,000,000 light years across, the dust of powdered watches would constitute a space-gas as dense as air. The number of atoms in the real space cloud, would require a number of seventy-one figures to write it down.

For all its tiny density, the dust cloud of space promises to be important to theories of astronomy. It may prove to be the source of Doctor Millikan's mysterious cosmic rays. Its combined gravitational attraction may affect the motions of nebulas and stars. Study of its chemical composition may yield important clues to the creation or destruction of matter, even to the beginning or the end of the world.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Ingenious Men Have Found Many Uses for this new Product

Plastic Wood, which handles like putty and hardens into wood, has been sold for home repair purposes for some four years. Recent developments in the industrial field have been most interesting.

"For pattern making Plastic Wood is more durable than wax or leather."

HOLES, cracks, wood blemishes, chipped mouldings—little by little as Plastic Wood made itself useful to men at home, these same men began to see its value in their factories to solve upkeep and production problems. Their ingenuity has created many time and labor saving uses for this unusual product.

The modern pattern shop finishes patterns; the piano manufacturer fills blemishes in oak, mahogany or ebony; the furniture manufacturer has found Plastic Wood unequalled in covering counter-sunk screws; the shoe manufacturer for repairing and re-fashioning lasts.

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